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Exploring the Impact of Life Science Intermediaries on Knowledge Exchange and Commercialisation: Using a Constructivist Grounded Theory Methodology

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Abstract

This thesis presents a Constructivist Grounded Theory study that explores the impact that life science specific intermediaries have on knowledge exchange and commercialisation. Many of the life science intermediaries (LSIs) that operate to bridge the divide between industry and academia receive public funding, and many have come and gone. It is important for us to better understand the reasons behind this turnover and how we can develop LSIs that have staying power. The research explores what LSIs are and the different ways they can impact on knowledge exchange and commercialisation. The study engaged 22 different LSIs sites from the UK, Holland and France. These 22 different LSIs have been placed into five different Case intermediary models, moreover, 30 interviews were conducted, informal observations were collected and field notes also known as memos were taken throughout the research process. Through the use of Constructivist Grounded Theory five theoretical concepts emerged, these included the following: that a LSI needed to have commercialisation targets, those with KEC objectives embedded had more chance of gaining further funding, and they require sufficient time and that funding resources are adequate and they should employ staff from both academia and industry within the LSI. A theoretical framework model that can be used to help design and develop a high functioning LSI is presented. Discussions with policy decision makers and the expectations from a range of stakeholders feed into this framework model.

The theory development adds to the knowledge on innovation intermediaries and in particular the sectoral systems of innovation (SSI) which allows for a more focused

approach on innovation intermediaries from a single sector viewpoint. Furthermore, the study feeds into more recent research on the reason why intermediaries fail.

Keywords: Constructivist Grounded Theory, Life Science Intermediaries, Knowledge Exchange and Commercialisation, Expectations Gap,

Chapter 1 Introduction

1.1 Introduction

There has emerged a new race between nations in recent years to drive innovation forward in order to establish a leading position as a technology innovator and thereby benefit from first mover advantages (Hauser 2010, 2014, Andersen, De Silva, and Levy 2013, Mazzucato 2011, 2013, Parker, Hine and Eastwood 2009). This has led to the drive in the UK and other European nations to commercialise innovative technologies in the hope of achieving this. There has been a wealth of research into how this is to be reached and it is now widely accepted that key to achieving this desired goal is to increase the interactions between academia and industry to help push technologies that may have languished in academia out into the market place (Lambert Review 2003, Kearnes and Wienroth 2011, Hauser 2010, 2014, Wilson 2012, Higher Education Funding Council for England 2016, Kruss and Visser 2017). One method employed by governments in achieving this goal is the use of Intermediaries (Wilson 2012, Howells 2006, Lopez and Vanheverbeke 2010). Intermediaries generally work at the interface between academia and industry ‘bridging the gap’ between the two sectors. They facilitate the transfer and exchange of knowledge (discussed later in Chapter 3) that drive the innovation process. Specifically, this research will investigate the role that the various life science intermediaries (LSIs) play, the part they play in the innovation process, and in particular how they impact on Knowledge Exchange and Commercialisation (KEC).

Examining the factors that impact on stakeholder value will help to identify the competitive advantage that LSIs can bring. Their role in the development of entrepreneurship will be determined through their Knowledge Exchange and Commercialisation activities. Do they inhibit or facilitate KEC, are they an aid to entrepreneurs, or do they get in the way?

This research will examine the factors that influence effective KEC functioning within a range of LSI case models and how policy impacts on the success or failure of LSIs.

1.2 Background and Context to the Research

1.2.1 *What is an Intermediary?*

A wide range of intermediaries have been identified in the literature. These include consultants, think tanks (Meyer 2010), incubators (public and private), science/research parks (Wright et al. 2008, Lopez-Vega and Vanheverbeke 2010, Siegel, Westhead and Wright 2003, Phan, Siegel and Wright 2005, Bigliardi et al. 2006), public funded network intermediaries, trade associations, research councils, and Technology Transfer Offices (TTOs) based in Public Research Organisations (PROs) like universities and research institutes (Siegel, Westhead and Wright 2003, Kearnes and Wienroth 2011, Andersen, De Silva and Levy 2013, Eveleens, Rijnsoever and Niesten 2016). The spectrum is broad, and some researchers even include consortia, foundations, patent firms, business angel networks and regional development agencies in their list of intermediaries (Metcalfe 2010). Trying to research all the different intermediaries would be a vast undertaking and it would be difficult to produce any meaningful results as they all have different cultures, work ethics, performance measures and business models. Therefore this PhD Study has been limited to intermediaries that are working to bridge the gap specifically in the life science sector.

An intermediary is also referred to as a bridging organisation (Sapsed, Grantham and DeFillippi 2007) or as a broker (Hargadon & Sutton 1997, Wilson 2012, Smedlund 2006). It is essentially an organisation that facilitates connections between two or more organisations or sectors. Howells (2006) defined an intermediary as “An organisation or body that acts as an agent or broker in any aspect of the innovation process between two or more parties" (Howells 2006, p.715)

Commercial organisations using these intermediaries are usually those lacking in the quality relationships needed to achieve this unaided, such as new SME's which do not have robust networks that they can easily tap into. They rely on an intermediary to connect them to suitable partners from either industry or academia. The main purpose of an intermediary is to carry out a bridging function as defined by Shohet and Prevezer (1996). They defined intermediaries as public and private organisations that act as agents transferring technology between hosts and users. More recently Wilson (2012) defined the role of an intermediary as: "organisations or individuals that occupy the space between the researcher and commercial exploitation of that research" (Wilson 2012, p.54).

1.2.2 *Innovation Intermediaries*

> *"Innovation intermediaries are organisations or groups within organisations that work to enable innovation, either directly by enabling the innovativeness of one or more firms, or indirectly by enhancing the innovative capacity of regions, nations or sectors". (Dalziel 2010, p.2)*

The literature on innovation intermediaries has been steadily growing. Still only a relatively new area of research, it came to prominence in 2006 when Howells (2006) discussed a new class of overarching organisation he called the innovation intermediary. Since then a number of researchers have attempted to develop methodologies for measuring outcomes that are viable across different types of intermediaries (Dalziel and Parjanen 2011). The differences in sectors and the vast array of business models that are employed make researching all innovation intermediaries an unmanageable undertaking.

In Howells's (2006) seminal paper he examined the roles played by intermediaries during the innovation process by studying members of the Association of Independent Research and Technology Organisations (AIRTO). Members of AIRTO include brokers, gatekeepers and consultants. His paper examined the role that these innovation intermediaries play within four areas including: technology transfer, innovation management, systems and networks and as service organisations. Howells listed the ten most common features of innovation intermediaries. These are:

1. scanning and information processing,
2. knowledge processing and combining,
3. gate keeping and brokering,
4. testing and validating
5. commercialisation,
6. foresight and diagnosis,
7. accreditation and standards,
8. regulation and arbitration,
9. intellectual property,
10. evaluation and training.

Building on Howells research, Lopez-Vega and Vanheverbeke (2010) reviewed 32 innovation intermediaries working in open and closed innovation markets. They concluded that innovation intermediaries help to facilitate the exchange of knowledge between partners and collaborators. In their research the role of innovation intermediaries was separated into 3 main functions: (1) connections, (2) collaboration and support, and (3) provision of technological services. These 3 functions streamlined Howells's 10 features.

Coeurderoy and Duplat (2008) used Howells's (2006) 10 most common features of innovation intermediaries to link five different intermediary institutes with firms to examine their embeddedness within the networks they operate in. They examined their relational, structural and cognitive embeddedness, and sought to show how these intermediary institutes balanced the "learning" functions with the intellectual property (IP) "protecting" functions within the networks (Coeurderoy and Duplat 2008). They concluded that both functions were protected within the strategic alliances that were formed between the intermediary institutes and the firms within the networks.

The researchers referenced above have provided us with a good understanding of the role of a wide range of innovation intermediaries. This knowledge will be used and built upon by this PhD research study as it delves into some of these areas of the literature.

Although a few researchers have explored some of the physical LSIs like science parks and incubators, most have focused their research on the many virtual or on-line innovation intermediaries like NineSigma (Howells 2006), where the bridging process is carried out in a different way with many problem solvers working on an innovation problem.

1.2.3 *What is a Life Science Intermediary?*

This research will focus on the innovation intermediaries operating within the life science sector called life-science Intermediaries (LSIs). They have a broad spectrum that covers biotechnology, agricultural biology, healthcare, medical devices and/or disease specific networks. There are a number of well-established sector specific intermediaries operating within the life science sector across the globe as many nations have invested in them as a means of improving their innovation processes (Hauser 2010, 2014, Dalziel 2010). This research will be focusing on physical intermediaries operating across the UK. An international perspective will also be brought by including life science intermediaries in Lyon (France) and Leiden (Holland). Five Case LSI models will be included and are listed in Table 1 below. They include regional and national LSIs that provide a bridging function for organisations within the network or cluster in which they are physically located. Although the researcher has had some access to LSIs in both Holland and France, there are too few international LSIs to justify a true comparative analysis. They have therefore been included to support the research findings. Had time permitted, a fuller international comparison that included LSIs from the USA would have been included.

The Case LSIs that have been recruited for the study all fit into one of the five business models set out in Table 1 below. Details of the participant organisations in each of these cases are detailed in Chapter 4. The individuals from within the organisations are not revealed in this study.

Table 1: The 5 Case LSI models included

Case 1 LSIs	Science Parks and Incubators
Case 2 LSIs	The Cluster Network Organisations
Case 3 LSIs	The Research Institutes and Innovation Centres
Case 4 LSIs	The Sector Specific Thematic Intermediaries
Case 5 LSIs	The Technology Transfer Offices

The landscape in the UK for LSIs is changing rapidly, and there appears to be a focus on national rather than regional networks emerging (Lawton-Smith and Romeo 2015). There are differences in the funding sources that underpin these LSIs, including:

- Central Government,

- Economic development agencies,
- Local councils, and
- Membership fees.

The trend in the UK at the local level is for the LSIs to close down once their funding runs out (House of Commons Science and Technology Committee 2011, Brown, Gregson and Mason 2016). Many of these networks had been given funding with the proviso that they became self-funding after a period of time: this has very rarely happened (this is discussed further in Chapters 5 and 6). However, the recent call from the Biotechnology and Biological Sciences Research Council (BBSRC) for the creation of an agricultural network focused on bio-energy, indicates in the requirements that the BBSRC does not expect the network to become self-financing beyond the funding period. This is a significant change in policy for publicly funded LSIs and appears more realistic (BBSRC 2013). This research will allow us to review some of the LSIs that have recently closed down (House of Commons Science and Technology Committee 2011, Brown, Gregson and Mason 2016), we explore their impact and if they had a role in providing KEC. Through this we might understand why some LSIs do not continue beyond their funding period.

1.2.4 *The importance of Life Science Intermediaries to the Economy*

Innovation has been identified as an important source of economic wealth (Wilson 2012, Mazzucato 2013, Higher Education Funding Council for England 2016). Innovations that emerge from the life sciences sector have a potential to drive new company formation, increase employment, inward investment and to generate products that can be sold globally. It has become a priority sector for the UK and many other countries (Shohert and Prevezer 1996, Hansson, Husted and Vestergaard 2005).

Many Governments have looked at where other nations have been successful at translating life science innovation into economic benefit (Breznitz and Anderson 2005). Many successful countries have used intermediaries to help bridge the gap between different sectors and grow their life science clusters (Morgan 1997, 2011, Smedlund 2006, Lopez-vegas and Vanhaveverbeke 2010, Suvinen, Konttinen and Nieminen 2010). Both academia and industry have traditionally found it difficult to bridge the sector divide between them. The German Faunhofer Centres (discussed later in Chapter 3) have been intensely scrutinized and many have tried to emulate them (Hauser 2010, 2014, Reid et al. 2010, Mina, Connell and Hughes 2009). In the UK there has been a debate as to whether we can do something similar and indeed we have tried to implement similar models, for example the Catapult Centres and the Intermediary Technology Institutes (ITI's) (both are discussed later in this chapter). There is a belief that intermediaries can help in the drive for prosperity by bridging the divide between sectors, producers and users of knowledge. Over a number of years, many have supported the view that intermediaries can help (Hauser 2010, 2014, Brown, Gregson and Mason 2016). The continued investment into intermediaries including the new Catapult Centres, which will receive £250 Million over 10 years (Hauser 2010), and is worthy of further investigation to establish whether they are as effective and valuable as perceived. This research could potentially try to inform a range of interested parties including policy-makers, funders and practitioners from within the sector understand the effectiveness of LSIs. We discuss the specific aims of the research in the next section.

1.3 Research Aims and Objectives

Based on an in-depth review of the literature on the life sciences sector and innovation intermediaries in addition to the researcher's own experience of working in the sector, the decision was made to focus this study on life science specific intermediaries, with a focus on their impact on KEC processes. This will be crucial in understanding their overall value in terms of economic and societal benefits. In order to decipher their KEC potential a closer look at the relationship between the LSIs and their stakeholders, and how they operate, will help to determine the impact within each intermediary case being investigated in this study. More specifically this research will focus on the following research objectives:

1. Investigate the role and function of a range of LS intermediaries within the UK and Europe (Holland and France)
2. Explore the ecosystem in which each case LSI is located with respect to their stakeholders
3. Explore the perceptions and expectations of LSI stakeholders
4. Review how outcomes are measured and reported in each case LSI
5. Explore the potential for commercialisation outputs from KEC, including:
    a. Spin-outs and start-ups
    b. Licensing
    c. Collaborations
    d. Inward investments

1.4 The Research Questions

While reviewing the literature for the first time, the following research questions were identified as below:

RQ1: Are LSIs important for the commercialisation of research?

RQ2: What are the key perceptions and expectations of the KEC value that LSIs hold?

After a thorough review of the literature on LSIs it became clear that the gaps in the literature were related to answering the above questions. A number of subsequent questions will also be answered. These emerged through a second deep examination of the literature and are linked to the objectives which help in answering the two main research questions. The two subsequent research questions identified are:

RQ3. Why do some LSIs fail to survive beyond their initial funding?

RQ4. How important is an anchor organisation to a LSI?

The two main research questions were inspired by the research done by Suvinen, Konttinen and Nieminen (2010) who carried out research looking at innovation intermediaries operating in two different sectors: biotechnology and optoelectronics in Finland. They used the triple helix lens to determine the value of intermediaries in the two sectors and their commercialisation impact. Their research question asked whether intermediaries were necessary at all in the commercialisation of innovations. This PhD research study will address a similar question; however it would be focused on a range of LSIs in different regional and national innovation settings, which are either privately or publicly funded. By addressing the research questions we will explore how important LSIs are for the commercialisation of innovations rather than whether they are necessary at all. The research carried out by Suvinen, Konttinen and Nieminen (2010) concludes that innovation intermediaries are necessary in the sectors they explored. This PhD research study will address a similar question in RQ1. What this question asks is, can we achieve the same outcomes without a LSIs. Moreover, it will assess the impact each case LSI has on KEC. This builds on the research by Suvinen, Konttinen and Nieminen (2010), however it takes a different slant in that it will focus on one sector and use Grounded Theory Methodology (GTM), rather than the Triple Helix Methodology as employed by Suvinen, Konttinen and Nieminen (2010). GTM allows for theories to emerge that may validate the earlier research. The decision to use GTM was supported by the conclusions of Suvinen, Konttinen and Nieminen (2010) that the Triple Helix had a poor analytic capacity.

The subsequent research questions (RQ3 and RQ4) emerged from research carried out by Brown, Gregson and Mason (2016) who explored the reasons for the Intermediary Technology Institutes (ITIs) failure in Scotland from a policy perspective. This study will endeavour to address these questions, and they will be analysed and discussed in Chapters 6 and 7 of this thesis. The success or failure of an intermediary is determined by its commercialisation outcomes and the results from this PhD study will attempt to explore how success and failure for LSIs are determined.

1.5 Methodology

Grounded Theory Methodology has been chosen for this study. The researcher explored various approaches when deciding on the appropriate theoretical methodology for this research as a number of methodologies have been used by others and many are available and applicable. The literature on GTM is divided when it comes to researching a previously well explored area. Although Strauss and Corbin in their 1994 paper claimed that GTM had the ability to generate novel and exciting ideas about things that have already been heavily investigated. O'Reilly, Paper and Marx (2012) said that GTM should not be chosen if the field has been heavily researched. They do however, also say that if the existing literature does not adequately explain the phenomenon then GTM can be used to develop a new theory. The researcher also had to decide if knowledge gained through earlier research of the sector would jeopardize the theory development stage of the research. However, providing that a researcher remains open to the data collected and avoids using any biases based on to pre-existing assumptions, it is possible to generate new theory based on the data collected (Goulding 2002, O'Reilly, Paper and Marx 2012). Furthermore, there is an argument that previous practical and theoretical experience of the phenomenon should be viewed as an asset (O'Reilly, Paper and Marx 2012, Fendt and Sachs 2008). This is because in order to make judgements on theoretical saturation a deeper understanding of the field through active professional experience will enable the researcher to recognise when the saturation point has been reached. Therefore, prior experience can benefit the research (Goulding 2002). Based on this review of the issues it was decided that applying a GTM was fully justifiable. This will be discussed further in Chapter 4.

Prior research on the sector comes from a range of literature, however, researchers Lopez-Vegas and Vanhaveverbeke (2010) suggested that due to the complex and idiosyncratic nature of innovation intermediaries, use of a single theoretical methodology to inform the phenomenon is simply not going to produce viable results. Investigating a range of LSIs and linking the literature on knowledge exchange and commercialisation with national and regional innovation systems and then the triple Helix, could generate theory that contributes to the existing literature on innovation intermediaries especially the literature on the sector specific intermediaries like LSIs.

However as discussed briefly previously, the decision was made not to use the lens of the Triple Helix methodology as previous research had deemed it insufficient in dealing with the analytical aspects of research (Suvinen, Konttinen and Nieminen 2010), plus the better methodology for generating new theory would be GTM. The other reasons for choosing GTM is that this research adapts an inductive approach which fits well with the researcher's philosophical stance including both epistemology and ontological views. This will also be discussed further under Research Methodology in chapter 4.

1.6 The Justification for this Research

Many researchers have studied innovation intermediaries that cover a number of different sectors. Few have examined sector specific intermediaries. This PhD research project will investigate and explore a range of physical innovation intermediaries involved in the commercialisation of life science innovations specifically. This qualitative study will link literature and theory on knowledge exchange and commercialisation (KEC), using a constructivist Grounded Theory Methodology that will focus on perceptions and expectations. To the researcher's knowledge this has not been done before. Innovation intermediaries are believed to provide an advantageous stimulus to innovation processes, however, because of the lack of any acceptable metrics of intermediary performance, it is difficult for innovation intermediaries to provide any definitive proof of their contributions (Dalziel and Parjanen 2011). Using a Constructivist GTM as in this research has allowed for an in-depth view of the Case LSI models, which includes identifying the metrics used by the different LSIs to measure success and failures.

The innovation process is highly complex and in order to generate new innovations multiple players are often required. The different organisations within the life science sector like biotech companies, large pharmaceutical companies and public research organisation (PRO's) don't naturally interact and it is because of this that LSIs were first created (Wilson 2012, Shohert and Prevezer 1996). These different organisations have different cultures and organisation structures that make it difficult to communicate across the boundaries.

This research study is motivated by the need to gain a greater understanding of the return on the investment in LSIs. It is not just the European and UK Governments who are investing in LSIs as a vehicle for transferring and exchanging knowledge, many other countries are following suit (Coeurderoy and Duplat 2008, Kodama 2008, Lee et al. 2010, Godfrey, Funk and Mbizvo 2010, Fornahl and Sorenson 2008, Dalziel & Parjanen 2012, Clausen 2013, Katzy et al. 2013, Smedlund 2012, Wu and Dalziel 2012). This study aims to illuminate the potential these LSIs have for KEC and for driving innovations out into the market place.

The key contributions of this PhD research project will not only be a greater understanding of the role and value of these intermediaries, but a better understanding of the perceptions and expectations held by those funding them and using them. The concept of intermediaries has been around for some time, but they are only now becoming more formalised, more recognised for their value, and more targeted by those seeking to improve the flow of knowledge (Wilson 2012, Hauser 2010, Howells 2006, Andersen, De Silva and Levi 2013).

1.7 Structure of this Thesis

Chapter 1 introduces the study and provides some context through some explanation as to the phenomenon that was studied, which includes discussing the importance of LSIs to the economy. The research aims, research questions and methodology chosen are all discussed. Then finally the chapter ends with a justification for the research and the organisation and structure of the thesis is presented.

Chapter 2 provides some background and historical context to the sector in which the phenomenon is placed. We discuss how the sector evolved and some context is provided for the use of patents within the sector. Finally we explore the different clusters within the UK, Europe and the USA.

Chapter 3 begins with an explanation of different types of knowledge and where life science innovations comes from. This is followed by a review of the literature on current and past LSIs that help us capture the essence of why this project is justified and important. The literature reviewed gives us insights into what to expect from this research. It also helped to identify where the gaps lie and some of the issues encountered in dealing with terminology.

Chapter 4 is the methodology and research methods chapter and here we start by delving into the aims and objectives of the research project. The research questions we have identified and our justification of choices made in the philosophical positioning of the research project are covered after the research aims and objectives. The chapter also provides an overview of the three main approaches in GTM and provides a comparison between them. The choices made are justified by the researcher. In the second half of the chapter we discuss the research methods used and then we explore the design and analysis of the research project and the data.

In Chapter 5 the results are presented and explained as are the coding procedures and how the different codes were identified for initial and focused coding. The chapter then presents the analysed data under each of the focused codes together with the observation data which is reviewed and analysed against the focused codes.

Chapter 6 is the discussion chapter and we start off by discussing the different forms of telling and how it was applied to the life cycle of each LSI. Next we compare the different case models and review what constitutes a high-performing LSI. Some of the key variables are analysed in relation to LSI performance in KEC and expectations of and barriers to success are included. The theoretical concepts that emerged are then discussed and finally the research is evaluated for its quality.

Chapter 7 is the conclusion chapter and discusses the contribution to knowledge that the study has made. It also links the literature reviewed with the research questions identified. The limitations of the study and recommendations for future research are also discussed. Finally reflections on the research process are made.

Chapter 2 Background History

2.1 Introduction

This chapter looks at the history and evolution of the life science sector and the birth of the biotechnology sector. In addition, we also discuss the importance of patents to the sector and the emergence of university intermediaries and why other LSIs have emerged. This then leads on to a review of the literature on life science clusters with examples of successful clusters in the USA, Europe and the UK.

2.2 The Evolution of Life Science Sector

Technological innovation accelerated after the Second World War and this has continued through to the present day (Salter et al. 2000, Prevezer and Toker 1996, Prevezer 2001). In the early 1970s the USA found itself having to compete with emerging economies from the Far East. Until this point the USA held a clear lead in technological innovations. When it was realised that these new competitors where selling technologies developed in the US in direct competition to the products developed locally, the US government realised that something needed to change. The decade between 1970 and 1980 is now known as the ‘Competitiveness Crisis’ era (Prevezer 2001). This period saw the rise in the genomic revolution and was driven further by the use of legislation for the US to help maintain their global edge. The legislation helped to safeguard Intellectual property (IP) so that it could benefit the US economy. The government examined the innovation processes within universities and decided that new legislation was needed across all PROs that would protect IP coming out from them (Jung et al. 2010). The ensuing legislation was a result of the perception at that time of the low rate on return on the investment on research and development and that the PROs were too ‘leaky’ when it came to valuable IP (Sampat, Mowery and Ziedonis 2003, Eisenberg 1996, United States of America Senate Judicial Committee 1979, p.2).

The Bayh-Dole Act of 1980 was a direct result of the drive to counteract the competitiveness crisis. It allowed universities to keep hold of any IP created from publicly funded research, thus creating the 'Patent Age' (Prevezer 2001), which is still in place today. The Act meant that the responsibility for patent filing would now rest with the university or institution. Prior to the Bayh-Dole Act universities were required to negotiate with individual funding agencies for various rights. This was time consuming and unnecessarily bureaucratic and ultimately impeded the transfer and commercialisation of publicly funded research (Sampat, Mowery and Ziedonis 2002, Jung et al. 2010). Before the Act came into force the reward system within academia was based on peer recognition and publication (Cohen et al. 2002, Rai 1999, Rai and Boyle 2007). Publishing all research made discoveries available to everyone. The government came to realise that this allowed foreign competitors easy access to economically valuable information. Now in the Patent Age they patent first and publish later. The act has been credited for the rapid development of the life sciences sector since 1980 – in particular the biotechnology sector – and played a part in incentivising investment in downstream R&D. This facilitated the commercialisation of biotechnology products (Mazzoleni and Nelson 1998, Cohen et al. 2002). It was in California that the idea to commercialise these technologies was initiated. With the discovery in 1973 of recombinant DNA techniques, LS innovations were further accelerated. The discovery was made in two US universities (San Diego and San Francisco) and two years later monoclonal antibodies were developed in the UK at the University of Cambridge. These discoveries signalled the start of the

Genomic Revolution and the biotechnology sector was born (Prevezer 2001, Hendry and Brown 2006, Salter and Martin 2001).

The impact of the patent system on the LS sector and in the development of LS clusters will be discussed in later this chapter. Cohen et al. (2002) and Hendry and Brown (2006) said that this explosion in activity has not happened in other sectors and that it appears to be unique to the LS sector, they believe that this is because the sector is highly research focused.

2.3 The Impact of Patents

Over the last three decades patenting has become an increasingly important goal in public funded research. In 1980 when the Bayh-Dole Act came into force the focus of patent ownership changed from the individual to the institution (Sampat, Mowery and Ziedonis 2003, Prevezer 2001). There have been many papers written about the impact the Bayh-Dole Act has had on innovation and commercialisation of publicly funded research. The act achieved its goal in reviving US competitiveness (Sampat, Mowery and Ziedonis 2003) and other countries seeing the benefits have followed suit with similar legislation, for example the UK followed in 1985 with their own version of the legislation as did Germany in 2002 and Japan in 2004 (Jung et al. 2010). There has been great interest and debate surrounding the issue of the quality of patents since the Bayh-Dole Act. Henderson, Jaffe and Tajtenberg (1998) argued that the quality of patents had declined, however the quantity had increased. However, Sampat, Mowery and Ziedonis (2003) concluded that there had been no decline in the quality. Their research is an indicator or measure of the impact patent quantity, quality and direction have had on publicly funded research outputs

(Azoulay, Ding and Stuart 2009, Stuart and Sorensen 2007). Other researchers worried about what the impact of commercial incentives would have on basic research. For example, would there be a shift to only fund research that is commercially viable or applications based research rather than on basic research (Sampat, Mowery and Ziedonis 2003, Calvert 2006, Christopherson, Kitson and Michie 2008, Salter and Martin 2001, Agrawal and Henderson 2002). Universities walk a fine line between balancing the scientific principles based on the 'Mertonian Norms' of science (Merton 1946) and funding for research (Calvert 2006, Salter and Martin 2001). There is relevant literature on the patenting system supporting both arguments. Heller and Eisenberg (1998) and Rai (1999) have argued against the patent system. Not filing a patent can have costly ramifications and there have been a number of well-known examples of what happens when inventors fail to patent an innovation. In the UK in the 1980's the University of Cambridge and the Medical Research Council failed to recognise the global commercial and scientific value of their discovery of Monoclonal Antibodies (Prevezer 1996, Sir Greg Winter, presentation to the annual BIA conference, Nov 2007, London). This and other similar examples of missed opportunities are part of the reason why Technology Transfer Offices (TTOs) were created to help safeguard a universities intellectual property. The changes in legislation were intended to generate profit for universities that could re-invested in new research projects. However, questions have been asked recently about how successful this strategy has been. The Financial Times revealed that UK universities spend £50miilion per annum on patenting, but that the majority of these patents have proved commercially worthless (Grimaldi et al. 2011).

> *"the riches they were promised from protecting IP have not materialized" (Gold et al. 2008, p.28)*

In nearly all universities licensing income has fallen short of investment in patents (Huggins, Johnson and Steffenson 2008). Only those few universities who have had blockbuster inventions see any significant revenue gains (Huggins, Johnson and Steffenson 2008).

The impact of patents on universities since the Bahy Dole Act has been mixed (Rai 1999). The negative consequences of patenting are not just that universities spend more on patents than they receive through their commercialisation. They can also lead to uncompetitive behaviour, like buying competing IP to kill it and thereby preventing it from reaching the market (Rai 1999). Others have acquired a portfolio of patents not to develop or commercialise them, but used to prosecute others for infringements. This is called "patent trolling" (Rai 1999). Patents have become fundamental in the financing of the LS sector (Kieff 2000) and LS research. There has been an explosion of growth in the LS sector, with thousands of new LS companies created since 1980. Many of those who in the early days were against the Bayh Dole type legislation have had their minds changed by the sheer wealth that patents have brought. We have also seen the number of university LS patents grow from 250 in 1980 to 2,700 by 1992 (Rai, 1999). The patent count has been an important metric in determining how successful the sector has been since the legislation came into force. This increase in the number of patents filed has not brought the rewards first imagined, especially for PRO's. This could be due to the fact that universities are not geared up to deal with the brokering of innovations effectively. The brokering role they have assumed has led to overvaluations of innovations in many cases which has resulted in a failure to see the return on their investments in patents.

2.4 Life Science Clusters

Life science clusters are geographic concentrations of interconnected businesses, including biotechnology and pharmaceutical firms, patent agents, venture capital organisations, accounting firms and biomedical supply firms, and the local research base like universities research institutes and hospitals. Clusters reduce the risks associated with developing and commercialising new and emerging technologies and support the wider adoption and diffusion of these new technologies (Hendry and Brown 2006, Ketels and Memedovic 2008, Department of Business, Innovation and Skills 2011).

LS clusters have developed and grown rapidly in the three decades since the start of the biotechnology revolution, these geographical agglomerations allow for knowledge spillovers to take place (Salter et al. 2000, Saxenian 1994, Hendry and Brown 2006, Sainsbury 1999). Spillovers are important to the growth of a cluster as they have been seen to accelerate the rate of new innovations taken to the market (Breschi and Lissoni 2001). These knowledge spillovers occur because of trust and collaboration that grows within a LS cluster (Asheim and Coenen 2005). Hendry and Brown (2006) found that the knowledge spillover effect is greater within LS clusters than any other sector.

The central hub of a life science cluster is usually a university or other PRO (Breznitz and Anderson 2005). However, sometimes it may also be a large pharmaceutical company or large biotech company (Powell 1998; Stuart and Sorensen 2003, 2007, Fornahl 2007). Researchers have examined the reasons these LS clusters have been created and concluded that they are a result of the companies spun out of the PRO, the academics behind these spin-outs usually want to remain close to their research base within the university (Zucker, Darby and Peng 1998, Breznitz and Anderson 2005). Universities have motivated academics to put more effort into commercialising their technologies, with the result that these activities will help supplement their research income (Breznitz and Anderson 2005). New entrepreneurs are attracted to locate in a LS cluster based on the following features: (1) The number of other biotechnology firms within the cluster (2) the research base, usually a local university (3) the presence of venture capital firms located within the cluster (Stuart and Sorensen 2003, Fornahl 2007). The work done by Stuart and Sorensen (2003) shows that although the university sits at the hub of the cluster, it is more important to a new entrepreneur to examine all the above features. Having access to qualified employees as well as funding is important to new companies (Owen-Smith and Powell 2004, Fornahl and Sorensen 2008).

Hendry and Brown (2006) undertook an important study using survey data to look at how companies benefitted from networking in LS clusters. They explored specifically the networking patterns of different firms and the intensity of the networking they did. They found that new smaller firms who had fewer resources had to seek help from LSIs in order to make the connections locally. The larger firms tended to network less locally and needed the help of the LSIs less. This has also been explored by Cohen and Leventhal (1990) and Drejer and Vinding (2007), they explained the phenomena as being due to the absorptive capacity of firms. The smaller firms were more in need of the help that a LSI could provide as they have low absorptive capacity, while the larger more mature biotech firms had a higher absorptive capacity, probably due to the fact they were connected to global markets (Huggins, Johnson and Steffenson 2008, Cohen Leventhal 1990, Drejer and Vinding 2007). Hendry and Brown (2006) drew similar conclusions also noting that LSIs were used less as the company matured and they too believed this was due to the need for the company to work more internationally, and that as they had grown they had developed strong relationships with pharmaceutical companies who operate globally. This is in line with some of the studies done on the subject of clusters (Saxanian 1994, Senker and Sharp 1997, Porter 2003). These conclude that there is a need for clustering of companies in a sector as they facilitate the process of knowledge exchange and transfer for emerging organisations and that local clustering allows for face to face interactions – usually at events organised by LSIs.

Therefore in summary, LS clusters are important for knowledge spillovers, and intermediaries within these clusters play an important dynamic role in helping to achieve this, which they do by increasing the social capacity of the organisations within their ecosystem. It is believed that clusters play an important part to the successful functioning of a LSI (Cooke 2002a, 2002b, Hendry and Brown 2006, Fornahl and Sorenson 2008, Prevezer 2008, Huber 2009). The next section reviews some high performing clusters in the USA and UK. Later in the chapter some of the Case LSIs that operate as cluster networks will be discussed, they are: BioDundee, One Nucleus and Lyon BioPole

2.4.1 *The US Perspective - The Boston Life Sciences Cluster*

As discussed earlier, this study will look at LSIs outside of the UK in order to learn from any successes. The USA has been at the forefront in the biotechnology revolution and has had unrivalled successes in the sector. Three regions within the USA led the revolution in the sector, these were San Francisco, San Diego and Boston (Prevezer 1996, Etzkowitz 2002). Based on the East Coast of the USA, Boston has one of the first and arguably the most successful life sciences clusters globally (Prevezer 2001, Etzkowitz and Dzisah 2008). It is a hotbed of entrepreneurial activity. The Boston life science cluster has recently outperformed the San Francisco Bay area (a West Coast LS cluster) and taken the top spot away from them (Weisman 2012). Since the foundation of these two clusters there has been competition for the leadership position (Weisman 2012). A closer examination of how Boston finally managed to topple San Francisco would add a depth of understanding of this successful progression and could reveal learning on the gaps we may encounter between the LS clusters in the USA and the UK and other European countries. This would indeed be an interesting area to research, however, it would require resources that are not available to this research project.

The San Francisco cluster had for many decades held the top spot and had the advantage of being close to Silicon Valley; it is believed that it is this proximity that had given the San Francisco cluster its edge over Boston for the past two decades (Prevezer 2001, Owen-Smith and Powell 2004). Silicon Valley had a thriving venture capital community, which, when presented with commercial potential from the life science sector, extended their investment portfolios to include biotechnology (Saxenian 1994). In addition, Saxenian (1994) concluded that Californian universities like Stanford were much more used to working with commercial partners than the Boston universities. However, according to Breznitz and Anderson (2005) this has now changed within the Boston cluster and may have contributed to its rise to the top.

There is literature on the region as an exemplary life science cluster and a number of researchers have written about the early history and evolution of this cluster (Prevezer 2001, Jung et al. 2010, Cooke 2002a). Cooke (2002a) discussed why the Boston cluster was so successful, concluding it was due to:

> *"Proximity and common backgrounds from educational institutions and the level of inter-firm interactions is high, global linkages to other clusters, linkages to pharmaceutical firms, to partners and customers are all pronounced"* (Cooke 2002a, p.139)

He concludes by saying that

> *"the Boston region clearly functions as a well-integrated regional innovation system"* (Cooke 2002a, p.140)

Other researchers have also written about the biotechnology networks in Boston (Owen-Smith and Powell 2004, Rank, Rank and Wald 2006, Powell et al. 2005, Oliver and Liebeskind 1998).

The Boston cluster has a rich history of academic excellence in the LS and PROs like Harvard University, Boston University, the Massachusetts Institute of Technology (MIT), Massachusetts General Hospital and the Whitehead Institute for Biomedical Research are all within the cluster (Powell et al. 2002). These PROs help attract world class talent to the cluster and a healthy venture capital sector has grown since the 1990s and has helped to fund the new start-up and spin-out companies (Powell et al. 2002, Owen-Smith and Powell 2004). As a consequence of all this, world-class companies have been attracted to the cluster. The cluster has had its ups and downs (Porter, Schwab and Sachs 2004) but has always been a dynamic cluster. Porter, Schwab and Sachs (2004), outlined the growth of the Boston cluster and the companies that grew up there to become billion dollar enterprises like Genetech, Biogen, Wyeth and others. By the early part of the 21st century a large number of pharmaceutical companies had moved there too. These pharmaceutical companies have further increased the attractiveness of the cluster and have drawn many to co-locate (Porter, Schwab and Sachs 2004). There is now a diverse range of organisations all linked by formal and informal networks that are supported by the many intermediaries that are funded by the federal government or the local regional government. This is in fact what makes Boston special, the extensive network of universities and intermediaries dedicated to supporting the sector (Lawton-Smith 2005).

It is hypothesised by Owen-Smith and Powell (2004) that a combination of factors including legislation, favourable funding, patent extensions and investing in niche markets have all had a positive effect on the region. Many of the biopharmaceutical companies that established in Boston, focused their R&D efforts on orphan drugs; this was a direct result of the 1983 Orphan Drug Act (Owen-Smith and Powell 2004). The orphan drugs market is very small in comparison to the blockbuster drug market that pharmaceutical companies usually aim for. A blockbuster drug has a much larger market and billion dollar sales potential. Big pharmaceutical companies are cautious about investing in R&D within the relatively low sales market for orphan diseases. This gap in the market and the favourable legislation and funding conditions allowed smaller biopharmaceutical companies like Genetech to move into this niche area. The risk these companies took has in many cases paid off and a number have been able to grow to the size of small pharmaceutical companies – helping to grow the Boston cluster to what it is today (Owen-Smith and Powell 2004).

2.4.2 *The UK Perspective - UK Life Sciences Cluster*

The history of the evolving sector in the UK has been well documented (Prevezer and Toker 1996, Prevezer 2001, Cooke 2001, Lawton-smith 2005, Lawton-smith and Bagchi-Sen 2006, Papaioannou 2009, Jung et al. 2010). The biotechnology revolution started in both the USA and the UK almost simultaneously (Prevezer 2001, Jung et al. 2010). Cambridge University was where the technique for creating monoclonal antibodies was discovered (Prevezer 2001). As discussed earlier the failure of the university to file a patent for this ground breaking and revolutionary technology has led to loss of revenues amounting to many millions of pounds (Jung et al. 2010). Since that early failure to realise and benefit from these discoveries the UK government has been determined to draw on this and not allow it to be repeated (Lambert 2003, Lawton-Smith 2005, Lawton-smith and Romeo 2015).

In the 1990's funding for activities to link industry and academia, which included cluster development, fell (Lawton-smith and Bagchi-Sen 2006). However, things started to improve in 1995. In 1997 the new government endeavoured to address the funding shortfall and focused on initiatives that promoted industry/academic interactions. At that time they also introduced a regionalisation agenda making universities and Regional Development Agencies (RDAs) responsible for innovation in a geographical area (Lawton-Smith and Bagchi-Sen 2006), thus indirectly stimulating the growth of clusters. In 2003 the Lambert Review was published and provided a detailed review of the current industry/academic interactions taking place in the UK. The report helped to further establish the importance of these interactions to the UK economy. The report recommended that new forms of formal and informal networks between business people and academics should be encouraged at the regional level and that there should be a greater role for the RDAs in facilitating knowledge exchange in their regions.

A number of LSIs have been established in the main UK LS clusters. These are mainly funded by central and local governments although there are a number of privately operated bio-incubators and business support networks that charge membership fees.

In Oxford and Cambridge LSIs were established primarily to help provide business support in the form of finance, dedicated buildings and networking (Lawton-Smith and Waters 2003, Waters and Lawton-Smith 2010). The outcome they were looking for was for companies to move from a research focus to the development of marketable products. Lawton-Smith and Bagchi-Sen (2006) discussed the creation of the Oxford network, which evolved from the Oxfordshire Investment Opportunity Network (OION) and a number of incubator parks. As the biotech sector evolved a number of these became sector specific and focused exclusively on the biotech and life science sector (Lawton-Smith and Romeo 2015). This included the Oxfordshire Biotech Net and the Oxford BioBusiness Centre, both of which shut down when funding was removed in 2005 (Lawton-Smith and Bagchi-Sen 2006). The Oxford Bioscience Network (OBN) was originally funded by the Government Office of the South East, however, has evolved into a membership organisation and is the main focus of networking in the LS sector in the Oxfordshire region (Lawton- Smith and Bagshi-Sen 2006, Lawton-Smith and Romeo 2015). OBN celebrates its 20th anniversary in 2017. Over the years it has grown its membership to over 400 organisations reaching outward from its central Oxfordshire location now outwards and across the UK and internationally (Oxford Biotechnology Network 2017).

Cooke (2002b) carried out a comparison between Cambridge Massachusetts and Cambridge UK. He explored the regional innovation systems of the two clusters and concluded that the UK Cambridge cluster, although smaller and less mature, had all the ingredients to make a successful LS cluster. It included a number of pharmaceutical companies like Glaxo Wellcome, SmithKline Beecham, and Merck, as well as large biotech companies like Amgen and Genzyme, which are important for getting access to funding and potential customers. In addition the Cambridge UK cluster has an abundance of science and technology parks including Cambridge

Science Park, St John's Innovation Centre and the Babraham Bio-incubator (Cooke 2002b; Papaioannou 2009).

The proximity of all these organisations has helped the Cambridge cluster to become significant in regional, national and global innovations systems (Cooke 2002b). As previously discussed another important factor in the creation of successful clusters is the access to high quality staff. The PROs located in Cambridge produced suitably qualified employees that can feed the companies within the LS cluster. Waters and Lawton-Smith (2010) found that there was a high employee turnover rate in both the Oxford and Cambridge clusters. This was due to the density of companies located within these clusters. Employees could jump from one company to another when specific skills were in short supply (Waters and Lawton-Smith 2010). It is thought that it is inevitable that Cambridge would start to experience the same issues on the cost of space and the poaching of staff as the Boston Cluster in the US currently experiences (Breznitz and Anderson 2005).

The main regional Cluster Network Organisation in Cambridge U was ERBI and it supported the sector by producing newsletters, conferences, training and links to other networks located nationally and internationally (Cooke 2002b). Like OBN, ERBI was originally funded by the RDAs and once that funding ended, they too had to evolve into a membership organisation. They merged with the London Biotechnology Network to become One Nucleus in 2010.

Leibovitz (2004) looked at the Scottish clusters focusing on the two major cities of Glasgow and Edinburgh. He looked at the type of organisations located within these clusters, and he explained that the clusters in Scotland were still 'embryonic'. In addition like Cooke (2002a) he concluded that a diverse mix of organisations including public research organisations (PROs), biotech companies, patent agents, accounting firms and business support networks are all paramount. However he emphasises the fact that they need to be highly specialised and sector focused (Leibovitz 2004). Research into Sectoral Systems of Innovations will be discussed in more detail under later. Leibovitz argues that organisations need to be highly specialised to work in the LS sector; which fits with the justification for Sectoral Systems of Innovation.

Papaioannou (2009) who also studied the Scottish cluster and compared it to the Cambridge cluster, said that one of the problems with Scotland was that they had fewer entrepreneurs, network brokers and investors who would invest in high risk companies. Rosiello (2007) looked at Scotland as a case study for innovation in biotechnology, and concluded that Scotland had been at the forefront in promoting and investing in cluster development. He discussed the companies and business support networks that operate across Scotland and concluded that most of the companies and PROs had to look outside their cluster to find suitable customers and funders and therefore needed to get help from intermediaries to do so.

The UK LS innovation ecosystem has been evolving over the last two decades. Government funding for LSIs like the Cluster Network Organisations (Case 2 LSIs from Table 1) has largely stopped, and as a result many LSIs have closed or have evolved in to membership organisations. Those that have survived include ERBI (now called One Nucleus), BioDundee and OBN. Both One Nucleus and BioDundee are included in this PhD research study. More recently, new regional Cluster Network Organisation have been created in the North of England (BioNow) and Wales (BioWales). It should be noted that in Scotland the Case 2 LSI model that is still operating is BioDundee. The Scottish Government has invested in a new intermediary model, the Innovation Centres. There are currently eight of these Innovation Centres, four of them within the LS sector:

- The Scottish Aquaculture Innovation Centre
- Stratified Medicines Innovation Centre
- Industrial Biotechnology Innovation Centre
- Digital Health and Care Institute

These Innovation Centres were launched in 2012 and are overseen and funded by the Scottish Funding Council (Scottish Funding Council 2016). They have been allocated £120 million over a 5 year period (Scottish Funding Council 2017). An independent review commissioned to assess whether the Innovation Centres were on track and meeting their targets was published in September 2016 (Scottish Funding Council 2016).

The review enabled the collection of evidence from a wide range of stakeholders from both industry and academia. It found that most of these Innovation Centres were on track for driving innovation between industry and academia. The criteria for success was based on the original delivery plan and the aims and objectives of the programme. The Innovation Centres are expected to leverage further funding from industry and other sources of public funding. They were created to be driven by the needs of industry, and to identify barriers to create economic benefit across Scotland. The Innovation Centres work with academia in a problem-solving consultancy capacity with industry to solve issues in product development and to utilise the science base to elucidate sometimes long-standing issues in certain industries (Scottish Funding Council 2016).

In order to achieve these goals the programme funders, SFC, support capital equipment purchases and postgraduate funded positions. The idea is that there is a fluid exchange of knowledge between the two sectors in the form of secondments and collaborations. The sharing of equipment between both sides is encouraged, and industry has access to technology within universities and universities can access technology and know-how in companies. In addition, the Innovation Centres have a focus on skills and training, up-skilling where gaps are identified (Scottish Funding Council 2016).

From this researcher's own 15 years' experience in the LS sector, the skills gap issue has been identified as a constant barrier to progress in the sector. Training for specific specialist skills in industry are costly and SME's are on tight budgets with most of their available resources being invested in product development; leaving little or nothing for training. Europe has been a valuable source of the skilled workers in the sector, but with Brexit on the horizon, industry, academia and Government need to start looking at measures to counteract a possible severe skills shortage in the UK.

2.4.3 *The European Perspective – Holland and France Life Sciences Clusters*

The literature on European clusters is fragmented. There have been papers written on European clusters including those in Portugal (Fontes 2001); the Basque region of Spain and Scotland (Cooke, Gomez Uranga and Etxebarria 1997), Scotland, Sweden and Denmark (Rosiello 2007), Italy (Bigliardi et al. 2006), Sweden and Ireland (Angelakis and Galanakis 2016).

Policy driven initiatives have played an important part in helping to grow the LS clusters in Europe. They specifically aid the connections between various players in a cluster (Rosiello 2007, Bruschi et al. 2011)

Two reports from KPMG have also proved useful on building a picture of clusters in Europe. From their report on site selection in Europe we can gain an understanding of the size and dynamism of the top 10 clusters (KPMG 2016). They rank Switzerland as the number one cluster, followed by UK, Holland, Ireland, Germany, Sweden and Finland. For this study we are focused on Holland and France. France has not made it into their top 10 rankings, however they are noted for offering competitive salaries. France and Holland also have the second highest ranking universities (4 each) on a global table of 100 along with Germany and Switzerland (KPMG 2016).

The two largest economies which include the UK and Germany have not attracted the same number of companies locating their regional headquarters, those countries who have surpassed the UK and Germany are Ireland and Holland (KPMG 2013). France and Switzerland have also been very successful at attracting LS companies, and France can offer lower R&D costs which provides an advantage to companies.

When this research started the UK was still firmly placed within the European Union, since June 2016 this has changed and the UK is currently in the process of leaving the EU and as discussed earlier Brexit may bring sweeping changes. This PhD research study is mainly focused on LSIs across the UK, however, when exploring what constitutes a success or failure, the researcher did focus on the German Fraunhofers as examples of successful intermediaries. The research study has also collected data from two European clusters in France and Holland, both of which will aid in the review on success and failure.

This section on clusters has provided some background on the sector and the location of the LSIs we will be exploring. The abundant literature on clusters has focused on a number of aspects that have helped them flourish and some of the barriers to their growth. The next Chapter will review where knowledge comes from and we will look at some of the LSIs that are current and those that have gone. In addition we discuss the different theories in relation to past studies.

Chapter 3 The Literature Review

3.1 Introduction

In the previous chapter in section 2.1 there is a review of the literature that provides some definitions as to what a life science intermediary is and why they are deemed important to the economy of the UK.

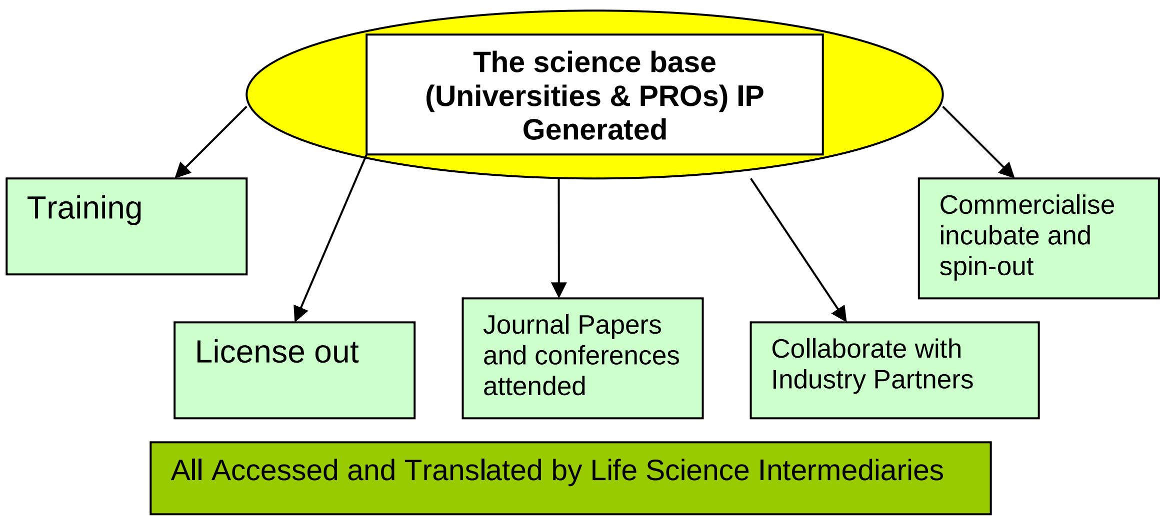
We then looked at the knowledge exchange and commercialisation process itself and some of the barriers to this exchange mechanism are then examined. An understanding of where innovations come from in the life sciences and how it is commercialised will help us understand better how effective LSIs might be at doing this. This issue and other related issues will be discussed within this chapter through reviewing the relevant literature on this topic.

3.2 Where Does Life Science Innovation Come From?

Invention and innovation is often created in public research organisations (PROs), which include universities, government research laboratories and research institutes. Basic research is generated mainly in PROs, and is described as unpredictable or curiosity-driven research (Calvert 2006) but occasionally this research may have potential applications which could mean the generation of new discoveries that can benefit society and the economy (Calvert 2006). Applied research was traditionally carried out in industry, but there is a blurring now of the boundaries with R&D moving out of industry and into academia (Calvert 2006).

It is notoriously difficult to get innovations out of PROs. In later sections of this literature review there will be a discussion on their mechanisms and how the various intermediaries like TTOs and bio-incubators have to engage with PROs and industry to help facilitate the transfer of technology out into the market. Figure 1 below shows where life science innovation comes from and how it moves out of PROs into the external environment. All of these paths can then be accessed by LSIs (See Figures 1 and 2).

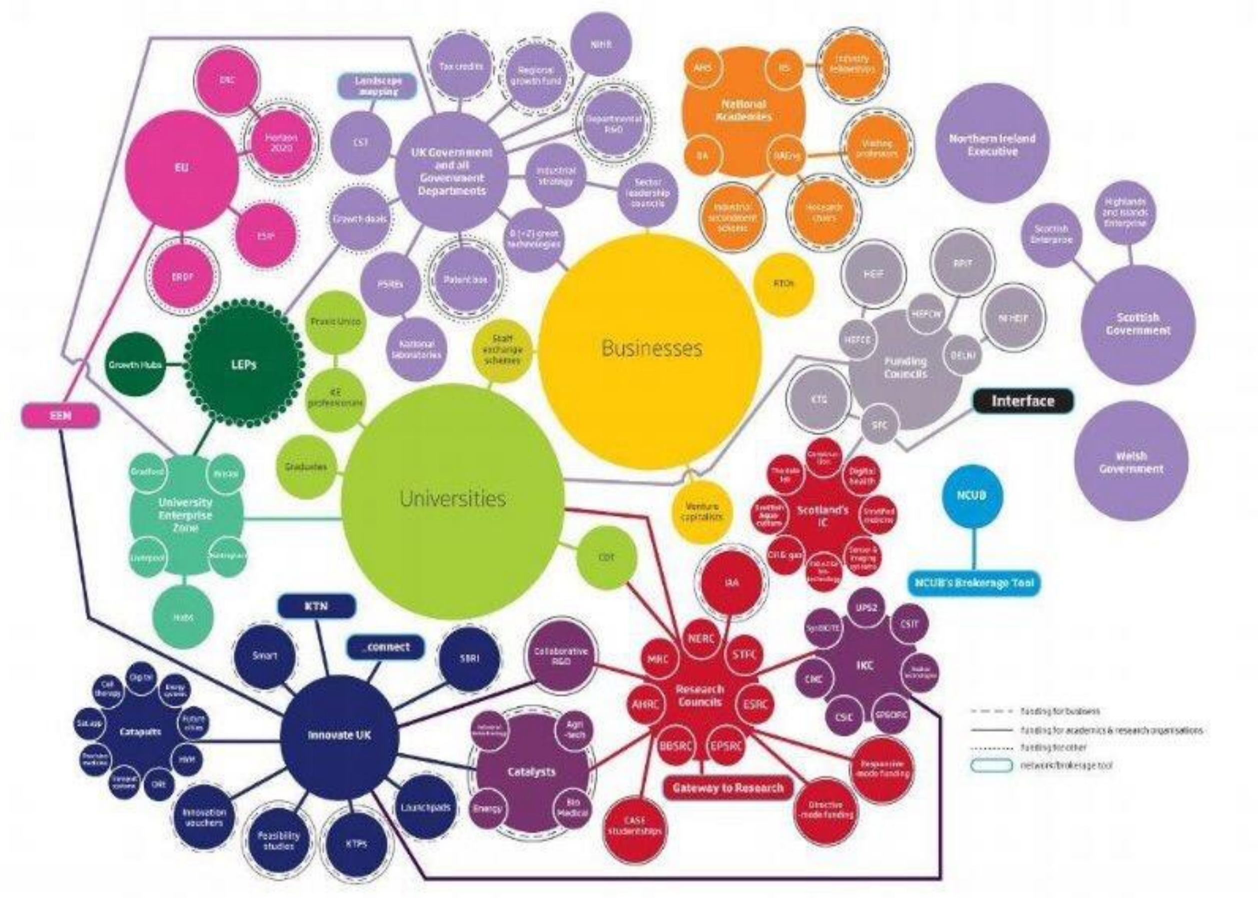
Figure 1. Getting Life Science Innovations Out



Simplistic representation of where life science innovations come from and how they flow out from the research base to the market

(Source: This Research)

Figure 2: The UK's Research and Innovation Landscape



The UK funding landscape and the pathways of knowledge flow within the UK innovation ecosystem.

Source: The Dowling Review of Business-University Research Collaborations (Department for Business, Innovation and Skills 2015)

3.3 The Knowledge Transfer and Exchange Process

The term Knowledge Exchange is a relatively recent phenomenon and has now superseded the term Knowledge Transfer. In the literature both terms are used - sometimes interchangeably. This has led to the popularity of the phrase 'knowledge translation and exchange' (Nutley, Walter and Davies 2007, Davies, Nutley and Walter 2008, Fox 2010) to describe knowledge exchange, since many in the field still want to hold onto the idea of the "translation" of knowledge or the movement of knowledge across boundaries (Davies, Nutley and Walter2008).

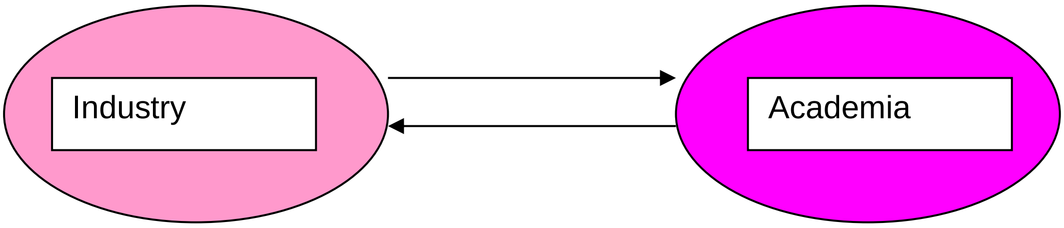
Knowledge exchange represents a multidirectional flow of knowledge through a relationship model, involving linkages and exchange (Jung et al. 2010, Gagnon 2011), whereas knowledge transfer is usually defined as the unidirectional transfer of information normally from producer to users of knowledge (Tait and Williams 1999, Davies, Nutley and Walter 2008, Christopherson, Kitson and Michie 2008 Jung et al. 2010). Christopherson, Kitson and Michie (2008, p.169) states that:

> *"The link is more of an exchange than a transfer which is paralleled in the research literature on innovation as having a 'systems' approach with feedback loops and multiple synergistic relationships".*

The reality is that there is much more complexity, and a variety of interactions are involved that had not been realised before.

When examining the literature it is clear that there has been a progression from the unidirectional model of knowledge transfer to the bi-directional model. An early study carried out by Iles and Yolles (2002) illustrates this. They described a project looking at how effective SME's are in the uptake of technological knowledge and identified the problem of getting benefits out of academia and into the market place. They developed a two-way or bi-directional model in which both sides were able to learn about how the other worked (See Figure 3).

Figure 3: The Bi-Directional Model

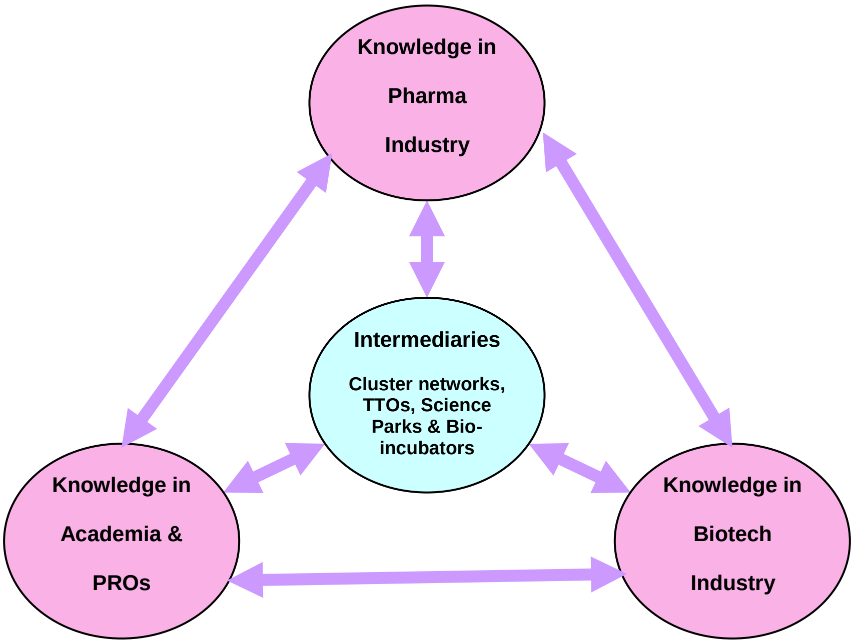


Knowledge can flow from one sector to the other, so both sectors can gain knowledge of the other. Source: This research.

Thus the academics gained insights into working with industry, for most of them this was an entirely new experience. Industry was able to learn about the untapped stores of knowledge within academia and how to work with academics to find applications for the research generated (Iles and Yolles 2002, Abreu et al. 2009). Each developed an understanding of what the other was looking for and learned more about their cultural differences. Although this early study revealed that much could be gained from Knowledge Transfer models, it was clear that the process was not a smooth one and that a knowledge intermediary was required to help bridge the gap between the two sectors (Jung et al. 2010). LSIs work in a multi-directional way gathering knowledge so that they can then pass it on. It is important to note that the high-tech imperative really requires this kind of knowledge exchange (Christopherson, Kitson and Michie 2008).

Figure 4 below, shows diagrammatically the various interactions that you can get from this multi-directional model. It shows the various organisations types and how knowledge is thought to flow between them and the various LSIs.

Figure 4: Knowledge Exchange Multi-directional Relationship Model.



This diagram illustrates the formal and informal flows of knowledge
Source: Based on Huggins, Johnson and Steffenson (2008)

3.3.1 *Barriers to Knowledge Exchange*

While Knowledge Exchange (KE) has received wide policy support it has been acknowledged that it may not always be as effective in facilitating the transfer of knowledge as theorised (Canadian Health Services Research Foundation 1999, Mitton et al. 2007). The differences in organisational culture and work ethics are among the barriers to successful knowledge exchange (Ward, House and Hamer 2009b, Clark and Kelly 2005, Mitton et al. 2007). The literature provides some discussion on the challenges of working practices and in particular the need for researchers to adapt to the deadlines, milestones and deliverables based approach more commonly found in industry (Mitton et al. 2007). Although over the last decade universities have become more entrepreneurial there are still barriers in facilitating the effective exchange of knowledge (Lawton-Smith and Bagchi-Sen 2006). This, according to Xiao and Tsui (2007), is because academia is driven by personal rather than institutional agendas and there is a need for impartiality when it comes to research. With the focus on research that has potential applications, some have argued that this impartiality may be in jeopardy (Lawton-Smith 2005, Christopherson, Kitson and Michie 2008).

As mentioned earlier this PhD research study is focused on multiple case LSIs and aims to explore specifically some of the barriers to knowledge exchange within the different models. What are the common practices and what are some of the LSIs doing that differentiates them from the norm? Can these differences have an impact on their KEC outcomes? It is hoped that by using GTM in this research that some of these questions will be explored. Answering these questions will hopefully go some distance to answer RQ2.

3.3.2 *Tacit and Codified Knowledge*

Tacit knowledge is difficult to collate and to communicate and the transfer of tacit knowledge involves social communications such as in networking (Christopherson, Kitson and Michie 2008). There is some evidence from a few studies that for effective knowledge exchange, intangibles like tacit knowledge, social capacity and relationship networks are important and are part of what is known as social capital (Zook 2004, Iles and Yolles 2002). Researchers who have looked at this, say that the greater the social capital the higher the quality of the brokerage outcomes (Xiao and Tsui 2007, Iles and Yalles 2002). According to Xiao and Tsui (2007) social capital is defined as information that can benefit the process and is a concept that refers to the connections within and between social networks. Burt (2002) describes social capital as a ‘bridge’ that connects actions which are not otherwise linked. The concept of social capital has become important in the literature surrounding regional and cluster studies and there is still some debate on a clear definition for social capital (Huber 2009). For the purposes of this research the definition of social capital is: deriving benefit from social interactions and networking (Christopherson, Kitson and Michie 2008).

The opposite of tacit knowledge is codified knowledge which is easier to articulate by TTOs and they find it relatively easy to market this knowledge (Wright et al. 2008). Lockett et al. (2005) found that very few TTOs within universities have the expertise to act as intermediaries in the transfer of tacit knowledge.

The exchange of tacit knowledge has been identified as one of the key components in the KEC process and in order for the exchange of tacit knowledge to take place social networking must be initiated. Therefore, the level of tacit knowledge exchange that each case LSI holds will help to identify the overall potential for KEC that the LSI possesses (Iles and Yolles 2002).

3.3.3 *The Open Innovation Model*

Open innovation was first brought to realisation by Chesbrough in 2003 (Chesbrough 2003). This new paradigm has added to our understanding of the innovation process. Chesbrough (2003) described open innovation as the '*purposive inflow and outflows of knowledge to accelerate internal innovation and expand markets for external use of innovation'*. The concept is not without its issues and a number of other researchers have criticised it (Chesbrough, Vanhaverbeke and West 2006).

Open innovation has become linked to innovation intermediaries as it has grown in popularity. The open innovation model allows companies to combine both internal and external ideas and innovations to create value (Chesbrough, 2003). The concept has attracted both researchers and practitioners. Despite this wealth of interest researchers like Elmquist, Fredberg and Ollila (2009) and Trott and Hartmann (2009) have highlighted the negative aspects of the model. This is because traditionally companies keep R&D activities behind closed doors in order to prevent any leakage of ideas to the outside world; this is known as the 'closed innovation system' and there are still valid reasons for a closed innovation model. The open innovation model has become increasingly popular with intermediaries of all kinds, in particular those innovation intermediaries who operate online. This open innovation model intermediary requires no physical walls as they are virtual intermediaries. They are able to bring disparate technology developers together. A number of studies have looked at the strategies and the role of these virtual innovation intermediaries and their ability to create value (Howells 2006, Hossain 2012, Roxas, Piroli and

Sorrentino 2011). These innovation intermediaries function more as technology mediators when comparing them to those with a physical presence.

The open innovation concept is believed to promote enhanced sharing of risks and benefits with partners. This is therefore what makes it a more ‘open’ system of innovation co-operation. The boundaries between partners become more porous to inward and outward flows of knowledge (Lee 2010).

Within LS we have seen that this model has been taken up by a number of pharmaceutical and biotechnology companies. Driven by the high cost of drug development, a number of forward thinking pharmaceutical companies have embraced the open innovation model in the hope of advancing their drug pipelines. The closed system of drug development costs approximately $1.2 billion for each potential drug candidate. Most pharmaceutical companies have been looking for novel ways of developing new drug candidates that are less costly and one of these pathways is to focus their efforts on open innovation systems (Fitzgerald 2008, Spencer 2014).

One successful implementer of the open innovation model has been the pharmaceutical giant GSK. They launched their open innovation policy in 2010, with the creation of ‘Open Lab’ based in Madrid Spain, where they are investing in malaria discovery with a focus on the developing world. In 2011, along with a triple helix partnership involving academia and Government, they helped to create the Stevenage Biocatalyst bio-incubator and accelerator. This bio-incubator was the first open innovation bio-incubator in the UK and is one of the Case LSIs in this research (Spencer 2014).

Open innovation has become an important model on the changing landscape of LSIs. RQ2 asks how effective the LSIs are at stimulating entrepreneurship through KEC activities. This study has managed to recruit two Open Innovation LSIs, the Stevenage BioCatalyst and RoCre at Rothamstem Research , this will allow for a review of the processes involved and how impactful they are at achieving KEC outcomes.

In October 2012 the BBSRC announced that they too were embracing the open innovation model. Their flagship bioscience research campus in Cambridge, the Babraham research campus, was to become an open innovation campus. This was done in collaboration with the two pharmaceutical companies based in the cluster AstraZeneca and Pfizer.

3.4 A Review of Literature on a range of Past and Current LSIs

Some of the more interesting LSIs will be discussed here to provide a picture of the range of LSIs operating within the sector. These LSI are all specifically physical or institutional types of intermediaries that have a KEC strategy.

3.4.1 *Technology Transfer Offices (TTOs)*

Nearly all US, UK and European universities have received funding by their governments to establish intermediaries known as Technology Transfer Offices (TTOs) (Ward, House and Hamer 2009a, 2009b, 2009c, Wright et al. 2008, Mina Connell and Hughes 2009, Howells and Edler 2011, Lawton-Smith and Bagchi-Sen 2006). They act as gatekeepers of the universities intellectual property (Wright 2008), by policing technological innovations that may have a commercial potential or to assess and protect IP and make it available to industry through licenses (Lawton-

Smith and Bagchi-Sen 2006; Huggins, Johnson and Seffenson 2008). They search for commercial opportunities, carry-out market research and help academics with applications for funding, essentially acting as a bridge between universities, industry and non-governmental organisations (Siegel, Westhead and Wright 2003). Many funding bodies now require details of any commercial output for the research they fund and this is the part that TTOs have traditionally assisted with (Lawton-Smith and Bagchi-Sen 2006, Lee and Ohta 2010). However, there is growing evidence that academics are now developing an understanding of the need for this essentially business side of the application and are completing applications themselves, thereby reducing the need for assistance from the TTO (Lee and Ohta 2010).

One of the primary goals of a TTO is to identify research that is patentable. Once the patent is filed they generally market technologies externally in order to license it to industry or to other PROs (Huggins, Johnson and Seffenson 2008, Lee and Ohta 2010, Ward, House and Hamer 2009c, Bramwell and Wolfe 2008). In most instances the university will not have the resources to fully commercialise their innovations, for example taking a molecule that may have the potential to become a drug to the market, cost $1.2 billion of investment and a period of approximately ten to twelve years (Ernst & Young 2010), this is beyond the resources of a university. There has been a trend in the last two decades for TTOs to help in the creation of new commercial entities otherwise known as spin-out companies (Huggins, Johnson and Steffenson 2008, Lee and Ohta 2010, Boon et al. 2011, Boh, De-Haan and Strom 2016). These new entities are usually incubated within the university to start with and then they are generally rolled out into a science park (Wright et al. 2008), remaining close by to the university, usually because the academic who founded the company can still be near to their research base within the university.

Over the years universities have generated many millions of pounds of income from licensing patented technology, which has helped to fund future research (Wright et al. 2008, Lockett et al. 2005). As discussed previously changes in legislation have given academics the freedom to found companies without jeopardizing their academic careers. A scientist can have nothing but a patent and depending on the strength of that innovation and the credibility of the academic they can obtain enough investment to create a company (Prevezer and Toker 1996, Prevezer 2001, Wright et al. 2008, Lockett et al. 2005, Calcagnini and Favearetto 2016). This is a simplistic view of spin-outs and start-ups, but it is essentially what happens. The TTOs help support the incubation period providing business guidance and funding pathways to these fledgling companies as they roll out of the universities and establish themselves.

Although TTOs perform a useful role in the exchange of knowledge, they do have limitations. The TTOs are successful at transferring codified or explicit knowledge, (which is the knowledge you find in IP, contracts and licenses) than in transferring tacit knowledge (discussed earlier) (Wright et al. 2008, Lockett et al. 2005).

Tacit knowledge is an important element within the knowledge exchange process and this deficiency within TTOs has given rise to a diverse range of LSI models, who do exchange tacit knowledge. These LSIs can facilitate the transfer of tacit knowledge through social networking events like; seminars, conferences, training events and workshops; it is this that differentiates them from TTOs.

There is a wealth of literature on the subject of TTOs and their growth within universities that in turn feeds the literature on industry-academic research (Siegel, Westhead and Wright 2003, Debackere and Veugelers 2005, Ward House and

Hamer 2009a, 2009c, Lee and Ohta 2010, Howells 2006, Howells and Edler 2011). Most authors consider that TTOs have a place in assisting universities to commercialise research and to facilitate the link between industry and academia, and are an important bridge that span the two sectors. It is possible that in the future TTOs may also start to help in the transference of tacit knowledge as well as codified knowledge. Of course the question is would this reduce or indeed remove the need for other models of LSIs?

3.4.2 *Incubators and Science Parks*

Government policies helped to create the TTOs and they have also helped in the establishment of incubators and science parks. These two types of intermediaries are both key in the exchange of knowledge between PROs and industry (Huggins, Johnson and Steffenson 2008). The creation of incubators and science parks are key mechanisms in the facilitation of knowledge spillovers (Huggins, Johnson and Steffenson 2008, Huber 2009). There are 62 bio-incubators across the UK (UK Science Park Association 2016). They consist of small laboratories and offices suitable for the early incubation of spin-out companies from the PRO base and some are subsidised by the PROs and therefore are normally affordable to the young spin-out companies that occupy them. The science parks range in size and provide services that include consulting, access to funding, access to venture capital, access to customers, and access to universities and networking within the local community (Huggins, Johnson and Steffenson 2008; Wright and Pardey 2006, Wright et al. 2008, Chan, Oerlemans and Pretorius 2009, Ahmad and Thornberry 2016).

The role of these incubators and science parks appears to take up the slack from TTOs by providing a platform for the exchange of tacit knowledge, crucial in the transfer and exchange of knowledge in the innovation process. They can help by finding funding opportunities for academic programmes, organising student placements and creating opportunities to help commercialise IP (Huggins, Johnson and Steffenson 2008, Cross and Thomas 2011). These opportunities are realised by hosting a range of events including seminars, workshops and training. Despite some evidence that mortality rates for the companies located in these incubators and science and technology parks have a tendency to fluctuate there has been an increase in the number of newly established incubators and science and technology parks across the UK (Huggins, Johnson and Steffenson 2008). It has been suggested by Huggins, Johnson and Steffenson (2008) that the mortality rate of the companies has been connected with real estate prices rather than novel science development within the companies. Huggins, Johnson and Steffenson (2008) say that these incubators and science parks can be linked to urban redevelopment and have been an important economic develop tool in *'lagging or uncompetitive regions'*.

Many of the incubators are part of the universities and supported financially by them, which is one of the main reasons they are able to subsidise the rents. University spin-offs have a close relationship with the university they spin-out from and are more likely to have university advisers than other firms (Cooke et al. 2006). Most of the management team from the spin-out companies are composed of academics who have a foot in both the new company and the university (Lawton-Smith 2005). In general, a longer time span is needed to develop LS products. This means that the spin-outs that are being incubated usually require a longer time to reach a more mature stage when they can transition into a science park. The incubation stage for the spin-out is fundamental to the success and sustainability of these small companies (Lawton-Smith 2005, Lawton-Smith and Bagchi-Sen 2006, Lawton-Smith and Romeo 2015, Kenney 1986, Shane 2004, Alsos, Hytti and Ljunggren 2011).

Owen-Smith and Powell (2004) found that biotech spin-out firms are strongly dependent on PRO's for skilled labour and novel scientific competencies that feed the companies located within the incubators and science and technology parks. This means that proximity is an important factor for incubators and science parks. The questions surrounding proximity will help to answer RQ4. Universities are considered the anchor organisation for university incubators and science parks.

RQ4. How important is an anchor organisation to a LSI?

The interviews will address this question with all participant organisations within each Case LSI. The question of proximity has been a focus of previous studies, including Cooke (2002a, 2007), and Breschi and Lissoni (2001). However, it has never been explored as part of the KEC value in an LSI. In this study the participant organisations recruited include LSIs from those with and without an anchor in close proximity.

3.4.3 *Fraunhofer Institutes*

The Fraunhofer society in Germany was created in 1949 (Howells and Elder 2011). It originally focused on geological research, however, soon spread to other fields. Today the society consists of 56 institutes with 14,000 employees in 40 locations (Mina, Connell and Hughes 2009, Fraunhofer-Gesellschaft 2008). Their main function is to '*support and augment*' activities within universities for knowledge exchange (Howells and Elder 2011). They provide a bridging function between organisations working within applied research and those of technology commercialisation (Mina, Connell and Hughes 2009). The Fraunhofer Institutes are largely funded through contracts with industry and PROs, both of which account for two thirds of their funding. The remaining third of the funding is from direct contributions by the federal government (Mina, Connell and Hughes 2009).

The Fraunhofer Institute model has been admired as well as researched over the years as an example of best practice. A number of academics and policy-makers have considered emulating the model (House of Commons Science and Technology Committee 2011, Hauser 2010, 2014). However other academics like Jeremy Howells and Jakob Edler believe that this model would not work in the UK. The main reason is that the Fraunhofer Institutes are extremely wide ranging and therefore have a number of different bridging roles in operation; they are not a one-size-fits-all concept (Howells 2008). Even though they are deemed successful, there have been a number of Fraunhofer Institute sub-divisions that have been closed due to poor performance (Hauser 2010).

A recent study by Betz et al. (2016) reviewed the German Fraunhofer Institutes with the intention of replicating the model in other countries, with a particular focus on South Korea. They developed a generalised model based on their Mittlestand triple helix model national innovation system, with 'innovation intermediaries' based in universities (Betz, Min and Shin 2014, Betts et al. 2016). The model is based on one-third funding from the government Fraunhofer society, one third from project contracts and one third from industrial contracts. The projects normally arise from proposals defined by industry and academia jointly (Betz et al. 2016)

They explored the Mittlestand triple helix Fraunhofer success through their national innovation systems. They explained that the German Government funds two different research organisations: 1). The Max Plank Institutes based within universities who receive funding for science research. These institutes generate new knowledge which is published in scientific journals (Betz et al. 2016). 2). In the universities with a Fraunhofer Institute the engineering research for technology and product development produced and institutes can produce commercially designed products and services, in addition to new production processes and tools (Betz et al. 2016).

This study shows clearly why the Fraunhofer model is so successful in helping German industry to develop the products and services it needs for commercial success.

> *Science indirectly benefits industry, but engineering directly benefits industry. Yet engineering research being based upon new science does not create a competitive advantage. This is why both Fraunhofer and Max Plank Institutes at German universities have been beneficial to the German economy, as innovation intermediaries –'technology progress embedded in engineering product/process services and based upon scientific progress' (Betz et al. 2016, p.598).*

3.4.4 *The Faraday Partnerships*

The 24 Faraday Partnerships covered many sectors and were first created in 1997 as a means of increasing industry and academic interactions (House of Commons Science and Technology Committee 2011). Their creation was a direct response to a 1993 UK Government white paper *'Realising Our Potential'* and their purpose was to facilitate knowledge exchange between industry and the research base (Cabinet Office 1993). The Faraday Partnerships followed the premise of the Fraunhofer model (Howells and Elder 2011, Hughes and Kitson 2012). They functioned as bridging organisations to support the uptake of new innovation technologies from PROs and industry. Their other roles included facilitating capacity building and to provide a platform for the exchange of tacit knowledge from networking activities (Zook 2004, House of Commons Science and Technology Committee 2011).

In a recent report on Technology Innovation Centres (TIC) commissioned by the House of Commons Science and Technology Committee (2011) the Faraday

Partnerships were examined in the context of lessons learnt from past initiatives. The research showed that by 2004 the Faraday Partnerships were being phased out as they had been classed as a failed initiative (House of Commons Science and Technology Committee 2011). The report outlined a number of reasons for this failure, highlighting the primary cause to be a lack of core funding, which meant that what funding they did have, was spread far too thinly. Another key reason was the lack of support from industry itself (House of Commons Science and Technology Committee 2011). Which forms an interesting question, why did industry not engage with them? This question will be reviewed later in chapter 6.

3.4.5 *The KTN's*

The Faraday Partnerships were replaced by the Knowledge Transfer Networks (KTN). The KTNs are funded from central government and are managed by the Technology Strategy Board, now Innovate UK (House of Commons Science and Technology Committee 2011). There were two life science KTN's, they are the HealthTech and Medicine KTN and the Biosciences KTN. The two life science KTNs were created from a number of successful Faraday Partnerships, they are still operating as nationwide intermediaries and are overseen by the Technology Strategy Board/Innovate UK. Today there is only one central KTN that has been consolidated. Instead of having many (8) separate KTNs with separate operational functions, there is now only one central operating unit.

3.4.6 *Intermediary Technology Institutes (ITIs)*

The ITIs were intermediaries created in Scotland in 2003 covering three different sectors, life sciences, digital media and energy and were also fashioned on the

Fraunhofer Institutes (OECD 2004, Rosiello 2007, OECD 2007, Papaioannou 2009, Brown, Gregson and Masson 2016). They were created to help bridge the gap for early stage innovative technologies. This meant working with PROs to identify technology that had a market potential (OECD 2007, Papaioannou 2009). ITI Life Sciences had some early successes. However, they started to flounder when they were unable to reach agreement with the TTOs on IPR ownership (Rosiello 2007, Papaioannou 2009, Brown, Gregson and Masson 2016). The ITIs were created as a 10 year initiative with £450 million of investment over the period. In March 2013 a national Sunday paper in Scotland announced that the 10 year period was now over and that after investing £231 million of the total budget the royalties gained were a paltry £600,000. Like the Faraday Partnerships the ITIs have now gained a place in history as another failed intermediary model (Brown, Gregson and Masson 2016).

This PhD study will aim to add to our understanding of why LSIs might fail to continue. A few of the LSIs recruited for the study had recently closed or were about to close, data collected from these LSIs will help answer RQ3.

> RQ3. Why do some LSI fail to survive beyond their funding stream?

3.4.7 *Catapult Centres*

The new Catapult Centres (previously known as the Technology Innovation Centres) that have emerged in the UK, were originally going to be based on the Fraunhofer Institute model (Hauser 2010), however, the new Catapult Centres have a model that has been determined by the national innovation system operating in the UK (Reid et al. 2010, Wilson 2012). Their location is determined by the strength of the cluster of organisations working in the focus area within the UK.

The Government's continued support for LSIs is evidenced in the creation in 2011 of a number of intermediary networks. One of these is the Cell Therapies Catapult Centre which was launched in early 2012 (Hauser 2010, House of Commons Science and Technology Committee 2011, Wilson 2012) and is housed within Guys and Thomas's Hospital in London. The benefits to companies who engage with network organisations like the Catapult Centres are well documented (Reid et al. 2010). Networks provide companies with knowledge of the sector, a network of contacts, the ability to identify funding, and access to the latest developments in the field. The Cell Therapies Catapult changed its name to the Cell and Gene Therapy Catapult in February 2016. They are one of the LSIs investigated in this research study.

3.4.8 *Literature on other LSI models used in the sector*

All of the LSIs discussed here in this section provide a bridging function and one of those that have been used successfully is the complex Product Development Partnerships (PDPs) like that used in the International Aids Vaccine Initiative (IAVI) and the Medicine for Malaria Venture (MMV) (Chataway et al. 2007). They are funded by the Bill and Melinda Gates Foundation, and employ knowledge intermediaries (brokers), whose dual intermediary role is to make funding and commercialisation decisions for products that can benefit the world's poor (Chataway et al. 2010).

Within medicine and healthcare, knowledge intermediaries are often used to bridge the divide between healthcare researchers and policy makers (Canadian Health Services Research Foundation 2006). It is widely accepted that healthcare researchers and policy makers operate within very different settings from each other (Clark and Kelly 2005, Kammen, Savigny and Sewankambo 2006, Carayannis and Campbell et al. 2011). Using a knowledge intermediary can help provide scientific analysis to support a policy decision that not only justifies that decision but also provides credibility and authority (The Change Foundation 2010)

Another interesting LSI is the Biotechnology Industry Association (BIA), a trade association funded by fee paying members from the LS business community and whose primary aim is to lobby Government on behalf of the sector (Hughes and Kitson 2012, Cooke 2001). They have a range of public sector members, but it is mainly industry that makes up their membership.

Within agriculture and environment there appears to be an increase in use of innovation intermediaries (Batterink et al. 2010, Holmes and Clark 2008). Both areas within the LS sector have started seeing increased funding for the provision of intermediaries and brokers. In February 2013 the BBSRC put out a call for groups interested in creating networks in industrial biotechnology & bio-energy they hope to establish agricultural and bio-energy biocatalyst networks in 2014 (Biotechnology and Biological Research Council 2014). In 2014 it was announced that £180 million in funding for these Agri-Tech centres and in 2015 the first centre called Agrimetrics was opened (Biotechnology and Biological Research Council 2015)

3.5 Section Summary

The literature review has looked into the background history of where LSIs came from and why they were necessary. TTOs were created and invested in, but they lacked the ability to transfer tacit knowledge. LSIs like the Cluster Network Organisation ERBI based in Cambridge and the Oxford Biosciences Network (OBN) were the next to be funded and supported by the government. These LSIs had specific funding periods after which they were expected to become self-financed. With the onset of the austerity programme in the UK, the RDAs were disbanded along with many of the Cluster Network Organisation LSIs which received their funding through them. More national innovation intermediary initiatives were then created which included the Faraday Partnerships, the Knowledge Transfer Networks and then most recently the UK Catapult Centres and the Scottish Innovation Centres. The new national models which include the Catapult Centres will it is hoped, fast-track innovations to market. The Catapult Centres will receive sufficient expertise, funding and infrastructure and be a place where industry and academia can work together to achieve commercialisation and product development success (Reid et al. 2010). As seen in the literature there are a number of different LSI models that have been created over the years, many have evolved while others have merged to create new organisation structures and a few have fallen by the way side.

This section has reviewed a number of LSIs that are past or current, this provides a picture of what success and failure look like. What constitutes failure and success and how it is measured are questions that led the researcher on this study path. The researcher had herself seen a number of LSIs come and go at quite an alarming rate. They all received substantial funding (the ITIs received £450 million over a 10 year period) to stimulate the innovation ecosystem. The more recent LSIs, the UK Catapults and the Scottish Innovation Centres, again have been provided with substantial funding, understanding why we believe they will succeed where other LSIs have failed will be an important outcome of this research study.

Have the intermediaries that have gone before failed because they were unsuccessful at meeting the targets set by their funders or did they fail because of changes in funding streams and policy direction? Is there a simple way of determining success and failure? These question will be addressed in this research study.

The House of Commons Science and Technology Committee (2011) report on the Faraday Partnerships contained evidence of unmet targets and failure from both academia and industry on engagement. This lack of engagement was particularly notable from industry and because of this the closure of the programme was inevitable. The UK Catapult programme has now replaced these defunct Faraday Partnership intermediaries. The aims and objectives are more or less the same, but their financial and operating model are quite different. Both the UK Catapults and the Scottish Innovation Centres follow the “a third/a third/a third” model.

The Catapults and the Innovation Centres have been allowed to become ‘not-for-profit’ commercial entities, this enables them to partner more easily with academia, which frequently has to partner with industry to apply for certain funding. In these partnerships they can then apply for other sources of public funding and including funding from industry.

The question relating to success and failure will need to be reviewed and discussed later in this thesis. However, at this stage the researcher will review this constant change of LSIs and also consider the expectation that funding is for a finite period after which there is an expectation that the LSI will become self-financing. Another question worth considering is: what does it actually mean for the ecosystem to have a ‘not-for-profit’ commercial LSI? Will they just be competing with the organisations out there for the same pots of money from public funds and industry?

3.6 The Literature on Past Studies

The literature reviewed for this research has been informed from a number of different disciplines including: Cluster theory, network dynamics, national and regional systems of innovation, innovation intermediaries, university-industry linking and the innovation management literature. The researcher has attempted to collate the different studies under the various theoretical methodological headings in order to clearly justify the logic for this study. To facilitate and explore in-depth the phenomenon under investigation the researcher has chosen a GTM and past research that uses GTM will be discussed later in this chapter.

3.6.1 *The Triple Helix*

In 2000 the triple helix concept was first discussed in the literature by Etzkowitz and Leydesdorff (2000) as a mechanism within the knowledge economy that can be used within the regional and national context (Sun and Negishi 2010, Dzisah and Etzkowitz 2008). The triple helix concept involves the relationship between industry, universities and governments (Leydesdorff and Meyer 2006). It is very important in promoting innovation and similar to what we've seen with the evolution of knowledge exchange theory discussed earlier in this chapter (Sun and Nagishi 2010). Etzkowitz (2003) calls the Triple Helix model an interactive model rather than a linear model of innovation.

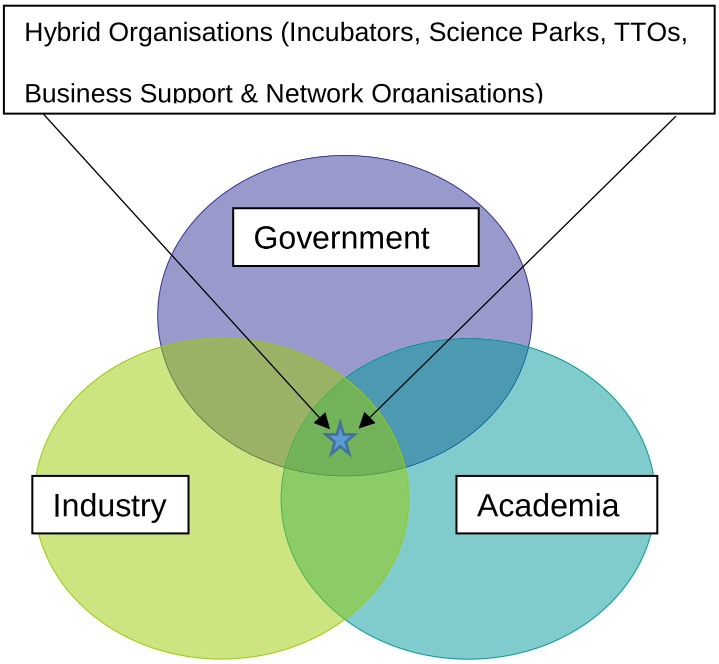
A number of researchers have argued that there are other dimensions to the triple helix model that are missing from the original model proposed by Etzkowitz and Leydesdorff (2000) (Sun and Nagishi 2010, Brundin et al. 2008, Etzkowitz and Zhou 2006). Sun and Nagishi (2010) believe the missing fourth sector to be that belonging to the international sector, whereas Brundin et al. (2008), suggests that yet another actor is missing – that of the entrepreneur. Etzkowitz and Zhou (2006) believes that introducing another strand regardless of what it is, would mean the idea of the triple helix structure as originally created would vanish. With this in mind Etzkowitz and Zhou (2006) suggest that the model should be modified freely at a local level to take into account the different national and regional innovations systems, rather than add a fourth dimension, which would change the triple helix structure altogether (Etzkowitz and Zhou 2006).

The triple helix is not a new concept as relationships between the three sectors existed before 2000 when the concept was first proposed by Etzkowitz and Leydesdorff (Etzkowitz 2003). However, the triple helix was promoted at a time when there was a need for it, and it is useful in explaining the many stakeholders needed to create an economically vibrant society driven by innovation. This meant that there was a rekindling of these relationships between the three sectors (Etzkowitz 2003). In the past the triple helix model has been useful in demonstrating entrepreneurship and growth, the three sectors in the model are supposed to co-operate jointly, initiate and convert innovation into growth (Etzkowitz 2003). This implies boundary spanning activities which has created hybrid organisations (Etzkowitz and Lydesdorff 2000, Etzkowitz and Zhou 2006, Brundin et al. 2008, Gulbrandsen 2011, Bellgardt et al. 2014). The hybrid organisations which include incubators, venture capital firms, sector specific networks, TTOs, business support organisations, and cluster network organisations have been created at the interface between academia, industry and government Etzkowitz 2003) (see Figure 5). This Venn diagram provides a good visual of the three overlapping sectors and how where the three all overlap is where you will find the hybrid organisations located. These hybrid organisations communicate and interact with all three sectors.

Bellgardt et al. (2014) explored the transformation of a science park in to a science city using Berlin-Adlershof as a case study. They conducted the study using a triple helix lens, with the focus being on the social and cultural dimensions within an urban development. Like the study carried out by Sun & Negishi (2010), who examined the three sectors within the triple helix (industry, academia and government), they found eventual erosion of relationships over time. Bellgardt et al. (2014) proposed that the use of intermediaries as an alternative model would improve facilitated interactions and connectivity within the three sectors of the triple helix model and would help to overcome the erosion seen.

The hybrid organisations that Etzkowitz and Leydesdorff (2000) discuss are, as previously explained, located at the intersection of all three sectors of the model and it is there that we find all the intermediaries that we are examining in this PhD study. The intermediaries chosen for this study have a remit to interact with all three of the local or national regional triple helix actors, building relationships and benefiting from engagement with them in order to flourish (Bellgardt et al. 2014). Metcalfe (2010) said that the intermediaries found at the intersection of the three helices or actors were ‘intentionally’ situated there.

Figure 5: The Triple Helix Model



A Venn diagram demonstrating the triple helix. The LSIs in this study all fall within the Hybrid organisations triangle
Adapted from Etzkowitz and Leydesdorff (2000)

This research is focused on examining the role of some of these hybrid organisations (see Figure 5) including the incubators, science parks and the business support and networking intermediaries like the cluster network organisations. A study by Suvinen, Konttinen and Nieminen (2010) looked at intermediary organisations in Finland working in two different sectors; the optoelectronics and biotechnology sectors. They asked whether intermediary organisations were needed for the exchange of knowledge and for commercialisation to take place. They used the triple helix framework to help arrive at the answer. Using empirical analysis they concluded that if each of the separate helices was working at full efficiency it would preclude the need for an intermediary to help bridge the gap (Suvinen, Konttinen and Nieminen 2010).

Suvinen, Konttinen and Nieminen (2010) concluded that little research on the functions of intermediaries had been explored, despite their growing importance within the literature. They further concluded that research should be focused on specific sectors rather than multiple sectors, like in their study, where they comparison the two different sectors. They interviewed key personnel based on their official position and activity in the commercialisation of knowledge. Additional interviewees were identified using the snowball technique and background work.

Their results showed that the commercialisation of knowledge had been more successful in the optoelectronics sector than in the biotechnology sector.

They used the triple helix as the methodology to explore if intermediaries are necessary in the commercialisation process and concluded that the market situation along with local culture and institutional character will have more impact than the links between the three helices of Government, industry and academia. They concluded that commercialisation will succeed without support infrastructure like intermediaries. In order to help validate this claim and take on board the suggestion that sectoral systems of innovation have a part to play, this PhD research study will endeavour to review this claim and to see if this is true for LSIs or whether the fact that the optoelectronics sector was indeed more successful at commercialisation than the biotechnology sector.

They discuss some of the issues of using the triple helix as a research methodology. These include the fact that the triple helix concept is too general and doesn't take into account different types of organisations which belong to regional or sectoral innovation networks. Their strategy raised other issues that were beyond the scope of the triple helix model to explain, and finally the model didn't provide a deep enough analysis or provide a deep explanation of the phenomena.

Both Bellgardt et al. (2014) and Suvinen, Konttinen and Nieminen (2010) used the triple helix as their methodology to explore the phenomena they were investigating. Neither study provided compelling results by using this methodology, which resulted in this PhD study not implementing it.

The triple helix literature has been explored as the helices play an important function within the innovation process. All of the LSIs models explored within this research sit in the interstitial space between all three helices as seen in Figure 5. Understanding better their role and function within the triple helix model will allow for a greater understanding of their value to the innovation ecosystems in which they reside.

3.6.2 *Sectoral Systems of Innovation*

Sectoral Systems of Innovation (SSIs) in relation to LSIs have been explored by a number of researchers, including Malerba and Montobbio 2003, McKelvey 2004, Metcalfe and Ramlogan 2005, Tait 2007.

The sector for LS has evolved over time and now includes large and small firms, which include Venture Capital firms, Patent firms, NHS and PROs (Malerba 2003). Therefore, it is not just the traditional LS organisation like the PROs and companies that are part of the sector, but also the sector support organisations who have specialist knowledge to enable them to work in the sector. The work ethos and cultural dynamics within the sector differentiates it from other sectors and makes comparing sectors difficult.

When comparing how we develop a product within the ICT sector with the development of a drug in the LS sector, the differences become apparent. The cost of developing a new drug is $1.2 billion from bench to patient and any failure along the drug discovery pathway can prove very costly. On top of this there are a number of regulatory hurdles that need to be overcome along that pathway; not traversing these hurdles will contribute to a costly failure. In the case of the ICT product development any failures encountered along the way are less costly, and development timelines are much shorter (Tait and Williams 1999, Pisano 2006, Tait 2007). There are fewer regulatory hurdles to deal with, if any (Tait 2007). This example emphasises the major differences between the two sectors and how attempting to compare them will skew the results.

Suvinen, Konttinen and Nieminen (2010), as previously mentioned, compared the Optoelectronics cluster with the Biotechnology cluster based on a science park in

Finland. Their results indicated that there was greater KEC success in the Optoelectronics cluster. Applying the differences identified using the SSIs we can see that timelines for product development (commercialisation) would have been different. Optoelectronics although regulated is not as heavily regulated as the Biotechnology field. This was one of the main reasons that Suvinen, Konttinen and Nieminen (2010) concluded that future research should take note of this fact.

However, Arocena and Sutz (2014) argue that SSIs are starting to unravel. They believe that the pharma and agritech sectors are sufficiently different and therefore should not be placed in the life sciences sector and should be analysed separately. Their research study is based on LS organisations in the Southern Hemisphere and they believe that there are three different areas within the LS sector that should be reviewed and analysed separately, they are:

1. Agrarian
2. Environmental
3. Industrial

These Southern Hemisphere countries included peripheral countries. Where legislation and the economic environment was sufficiently different in each of the three areas, they argued against using SSI (Gregersen and Segura 2003, Arocena and Sutz 2014). Moreover, they acknowledged that their additional segmentation justified the National Innovation Systems (NISs) that the organisations they were studying were based in.

In this PhD research study the LSIs used all conform to similarities such as having a physical presence, working within Knowledge Exchange and Commercialisation (either separately or jointly) and with only minor differences in targets. The 5 Case models of LSIs were chosen carefully in order to provide a comparison, although they all sit within the same sector. Hence the SSI theory is applied in this PhD study. With regards to the NIS, all of the LSIs within this study are located within the Northern Hemisphere and, including those LSIs from France and Holland, are within similar NISs. For example, regulatory systems will include: MHRA and FDA for regulation, the patenting system, quality assurance and CE markings on medical devices. The market forces will include: Venture Capital, Angel Networks, local and central government and European funding. These elements of the NIS apply to all the LSIs within this study.

3.6.3 *Cluster Theory and Network Dynamics*

There is now a wealth of literature on the networks of companies that develop around clusters. They mainly focus on the process of innovation within these networks (Swan and Scarbrough 2005; Owen-Smith and Powell 2004, BIS 2011). The network dynamics literature has focused on the relatively new biotechnology sector since its inception some thirty years ago (Powell 1998, Powell et al. 2005). It has been easier to follow the growth and development of the sector because of its '*emergent nature'* (Powell1998). Recent research on the importance of networks of inter-firm co-operation in the LS clusters shows that network co-operation is a critical factor in the exchange of information and knowledge (Rank, Rank and Wald 2006; Owen-Smith and Powell 2004). Owen-Smith and Powell (2004) looked at knowledge networks in Boston as channels and conduits for the flow of knowledge through a network. The knowledge transferred through linkages in the network determines broadly whether innovation benefits can be passed on to the organisations within the cluster (Owen-Smith and Powell 2004) and is a means of measuring commercialisation outcomes.

Another variable examined is location and proximity of networks of organisations within a cluster. Not all researchers however, believe that location and proximity within a cluster are necessary for a company to allow it to grow. Two of these researchers are Hendry and Brown (2006) who believes that there is not enough evidence to support any claim that LS firms will grow because of where they are located and their proximity to other firms. Others have claimed that clusters have developed and grown artificially due to government funding (Callon 1994, De Solla Price 1984). Specifically, policy, in addition to financial support, has created favourable conditions for these LS clusters to grow. Oakey, West and Manchester (2007) examined a number of clusters in various parts of the world including Silicon Valley (IT) and the Route 128 Corridor (Biotech). He concluded that policy had actually forced LS firms to adopt collaborative networking behaviours that were inconsistent with natural business processes (Oakey, West and Manchester 2007). In contrast the firms he looked at in Silicon Valley and Route 128 had grown organically mostly due to strong internal team working and not from networking within a cluster. He concludes that the highly popular cluster policy that many European countries and other nations are using to stimulate R&D collaborations in high-technology sectors like life sciences will not work and there is no evidence to support these policy efforts (Oakey, West an Manchester 2007). Finally he suggests that any capital investment in cluster development should be diverted to R&D collaborations between specific firms based on their management styles, strategies and their technologies rather than on their physical proximity within the cluster. The question of proximity to an anchor organisation is an important one and this question will be addressed by the RQ4 below.

RQ4. How important is an anchor organisation to a LSI?

Michael Porter in his seminal 1990 book ‘The Competitive Advantage of Nations’ (Porter 1990), looked at what constituted a successful cluster. He looked at cost and quality factors as well as the services and supply supporting services that serve common needs within the cluster. Another important factor identified by Porter was the need for competition. He said it was needed to drive improvement in quality and efficiency (Porter 1990, 2003, Breznitz and Anderson 2005). Other academics like Gulati (1995), Powell, Walter and Smith-Doerr (1996), Maskell and Malmberg (1999) and Mowery et al. (2004) have identified the need for linkages, relationships, ties, face to face encounters and partnerships. Piore and Sabel (1984) who studied a North Italian cluster noted that co-operation was equally important too, if not more important than, competition. Another important study by Saxenian (1994a) specifically stressed that networking, was an important contributor to the success of a cluster.

Therefore to sum up the literature on LS Clusters and network dynamics, there is important early literature that looks at the competitive behaviour of companies (Porter 2000), but more recently there has been more focus on the linkages, networking or communications and collaborations between the companies and PROs – or in other words the social capacity at work and in operation within these clusters. Some of this has been reviewed by other researchers including Huber (2009), Christopherson, Kitson and Michie (2008) and Hendry and Brown (2006).

3.6.4 *Absorptive Capacity*

Absorptive Capacity was first explained by Cohen and Levinthal (1990) and is defined as the ability of an organisation to see or recognise knowledge from external sources and to then assimilate it within the organisation and translate it into commercial benefit for the organisation.

A number of researchers have looked at the absorptive capacity of firms, these include Powell et al. (2005), Dahlander and Gann (2010), Clausen (2013), Cohen and Levinthal (1990), Chen and Wang (2008), Spithoven and Teirlinck (2010) and finally Spithoven, Clarysse and Knockaert (2011).

They have all postulated that external knowledge can only be used effectively to benefit an organisation if it has robust internal mechanisms to do so. Another researcher, Kodama (2008), reviewed the role of TTO's in the intermediation process in university – industry linkages. He explored how efficient the TTO's were at transferring technology under an absorptive capacity lens. He concluded that the absorptive capacity of all the organisations within the knowledge exchange process must have a level of absorptive capacity in order for effective exchange to take place.

Although this study is not focused on viewing LSI's under an absorptive capacity lens, it is an important factor within the ecosystem that each case LSI is located in. Part of the knowledge exchange process will involve the effectiveness of the LSI at identifying, assimilating and transferring relevant knowledge to its network of companies or members.

Absorptive capacity and the integration skills of firms are key factors when it comes to procuring the benefits from collaborative university-industry relationships. This transfer of knowledge from external collaborations allows companies to adapt and use the new skills and knowledge gained from these interactions to their benefit (Cohen & Levinthal 1990, Chen and Wang 2008, Spithoven & Teirlinck 2010, Spithoven, Clarysse and Knockaert 2011).

Absorptive capacity as a methodology to study how organisations learn is seen to help researchers measure how companies interact with a variety of organisations to strengthen their core service offering. Various ways of enhancing absorptive capacity of firms have been discussed and studied in previous literature. Spithoven, Clarysse and Knockaert (2011) have shown how collective research centres can act in order to increase absorptive capacity in traditional industries such as textiles and construction.

In order to benefit from absorptive capacities a company needs to have systems in place in order to capture these benefits from the engagement in border-spanning collaborations and open innovation processes (Fabrizio 2009). Firstly, organisations need to have the ability to recognize and make use of external knowledge. Experiential learning and investment of resources including time are important for this to happen (Cohen and Levinthal 1990). Moreover, building absorptive capacity entails developing three important conditions:

1. structures of communication within organisations as well as towards external environment
2. distribution of expertise in the organisation and
3. individual employees' absorptive capacities

   (Cohen and Levinthal 1990).

3.6.5 *The National and Regional Innovation System.*

The UK was greatly influenced by what had been happening in the US with the Bayh-Dole Act, which removed IP ownership from the individual academic and placed it with the university (Lawton Smith 2005, Lawton-Smith and Bagchi-Sen 2006). However, research carried out by Jung et al. (2010) showed that despite the UK emulating and adopting the features of the Bayh-Dole Act, the successes that it created in the US were not found in the UK. They believed that this was because of the differences in the national innovation systems of the two nations (Jung et al. 2010). Lawton Smith (2005) did a comparison of commercial success between organisations working in the gene therapy sector in both the USA and UK. This study highlighted the major differences of the national innovation systems at work in the different countries. She listed the top five reasons the USA had outperformed the UK these are listed below.

1. Easier access to seed capital in the US
2. More active role played by US venture Capitalist in the creation of new firms
3. Financial incentives and government support for high-tech companies in the USA
4. A lack of entrepreneurs in the UK
5. A larger more mature biotech sector in the USA

Another key difference between the USA and UK is the difference in experience and accumulated knowledge which is greater in the US due to the longer time span of their knowledge transfer activities. Another important reason was that their universities like MIT and Stanford were historically used to working with industry (Huggins, Johnson and Steffenson 2008, Cohen et al. 2002).

A number of researchers have studied the regional and national innovations systems at play within the UK clusters, including Dolereux and Parto (2005). There are a number of successful life science clusters in the UK; these include Cambridge (Papaionnou 2009, Cooke 2005), Oxford (Lawton Smith 2005, Lawton-Smith and Bagchi-Sen 2006), London (Shohet and Prevezer 1996) and Scotland (Rosiello 2007, Papaionnou 2009, Leibovitz 2004). The universities in these locations are usually co-located with top hospitals and are in receipt of the bulk of the research funding from the state, charities and the pharmaceutical industry (Lawton Smith and Bagchi-Sen 2006, Gertler and Vinodrai 2009). This means that funding is less of an issue than those universities outside of these areas.

The national and regional innovation systems theory will provide guidance to support the interviews that were conducted in this PhD research study. This links to the Lopez-Vega and Vanheverbeke (2010) suggestion that more than one literature should help to inform the phenomenon in order to achieving robust results.

3.6.6 *Actor Network Theory*

A number of researchers have focused their attention on biotechnology networks looking at inter-firm co-operation, including Rank, Rank and Wald (2006), Pittaway et al. (2004) and Swann et al. (2007). Rank, Rank and Wald (2004) collected data from relevant organisations in the southern part of Germany's BioNet cluster of organisations. They specifically examined the ties between actors and their different relationships; however the value of these ties was not examined as part of their research. Swan et al. (2010) did an exploratory study to identify mechanisms influencing biomedical innovation in two different nations the UK and the USA. They wanted to examine more closely the macro level relational and integrative capabilities that occur in the two nations. On examining the role of integrative and relational capabilities they were able to put forward a framework that would help explain the likely impact of such capabilities for innovation projects found at the micro level. The first part of the research consisted of field work which was based on interviews focussed on Boston in the USA and on the Oxford-Cambridge-London triangle in the UK. By doing this they establish how different innovation projects were organised in these two clusters. The second part consisted of longitudinal case studies of innovation projects (six in the USA and four in the UK).

They discussed some of the limitations of their study in their paper, including the sample size and fine tuning the modes so that they were less broad. This paper and the previous one by Rank, Rank and Wald (2006) both look at the relationships between stakeholders. In the Swan et al. (2007) paper they say that the UK needs better mechanisms for building bridges to allow knowledge to flow between PROs and commercial organisations as they all have different cultures.

3.7 Past studies Using GTM in relation to LSIs

This section will review and discuss some of the research that has been done using Grounded Theory as a methodology, although none are specifically focussed on the LS sector.

A study carried out by Lopez-vega and Vanheverbeke (2010) used a cross-case comparison to determine the typologies of intermediaries in open and closed markets. Their approach was that of grounded theory as their data analysis on theory-building trade-offs arose from the overlap between data collection and data analysis (Glaser and Strauss 1967, Van Manen, 1988). They were able to identify possible categories and relationships by simultaneously combining data collection with data analysis of their chosen case studies.

The case studies they used fell into 4 categories: innovation consultants, innovation traders, innovation incubators, and innovation mediators. They researched 32 intermediaries that identified with one of the 4 categories. The intermediaries used were from a range of different sectors involved in the intermediation process, and included Pfizer and Pharmalinks from the LS sector. They mapped their different strategies and business models from secondary data collection activities, including websites and periodicals. They made a decision to study the business models as it facilitated the inflow and outflow of knowledge and showed how the intermediaries helped to provide value to the firms they worked with. Their results suggested that a single body of literature could not explain the mechanisms used by heterogeneous forms of innovation intermediaries. Their research falls into 2 bodies of the literature relating to innovation intermediaries, that of Open and Close systems of innovation. They suggest that the best way to research them is to integrate or combine different literatures. The researchers in this study recognise that the intermediary sector generally is evolving rapidly and new yet undiscovered models are appearing that will need further investigation. They have listed a number of research questions that arose out of their research, these are:

1) What are the factors enabling successful intermediation for each intermediary?

2) How do companies identify, select and interact with innovation intermediaries?

3) How do innovation intermediaries facilitate the generation and integration of knowledge among various innovation players?

The second study to use GTM in its research was conducted by Baker, Edwards and Doidge (2012). They examined the factors that are attributed to the success of biotechnology firms in Malaysia. They choose GTM as an approach as little had been done on the sector in Malaysia and the approach is suitable when little or nothing is known about a phenomenon. Both research groups, Lopez-vega and Vanheverbeke (2010) and the Baker, Edwards and Doidge (2012) studies were the only two that used a GTM approach in their research in the LS sector found from the literature reviewed.

3.8 Gap Analysis

Table 2: Calls for Future Research

Call	Author and Publication Title
Our data does not allow us to conduct direct comparative analysis. They said their findings are suggestive of comparative differences and new theoretical propositions which future, more deductively oriented work could follow-up	Swan et al. 2007 Modes of organising biomedical innovations in the UK and US and the role of integrative and relational capabilities
From a more empirically driven research approach it would certainly be possible to derive more detailed results, which may be of considerable value with regard to further developing theories of interorganisational corporate networks	Rank, Rank and Wald 2006 Integrated Versus Core-Periphery Structures in Regional Biotechnology Networks
The meaning of higher education institutions for regional networking	Brenner and Patzelt 2008 Regional Innovation Systems. Clusters and Knowledge Networking

and clustering needs further investigation.	
A new innovation process model is needed in which the external knowledge intermediary plays a greater role than today	Gassmann, Daiber and Enkel 2011 The Role of Intermediaries in Cross-Industry Innovation Processes
Management studies on networks need to adopt a broader view than investigating the interfirm relationships within networks and to consider the role of players other than the firms in the network.	Coeurderoy and Duplat 2008 The Strategy and Governance of Networks Contributions to management science ISBN 3790-820571 pp311-323
Several other data sources and methodologies are needed to disentangle the true impact of public research on industrial R&D	Lawton-Smith and Bagchi-Sen 2006 University-Industry interactions: the case of the UK Biotech Industry
Further research is needed to examine in-depth the complexity of this phenomenon and in particular, to draw attention to the following question: do different forms of combined knowledge determine different brokerage models?	Abbate, Coppolino and Schiavone 2013 Knowledge creation through brokers: Some anecdotal evidence
Research that will explain the founding, growth and survival of innovation intermediaries	Dalziel 2010 Why do innovation intermediaries exist?
A closer more in-depth review of sector specific innovation intermediaries and not using the Triple Helix as a methodology	Suvinen, Konttinen and Nieminen 2010 How necessary are intermediary organisations in the commercialisation of research?
The relationship between networking and third party support networks	Pittaway et al. 2004 Networking and innovation: a systemic review of the evidence
Innovation scholars need to scrutinise failure as well as successes	Brown, Gregson and Mason 2016 A post-mortem of regional innovation policy failures: Scotland's intermediate technology initiative (ITI)

The above table shows the gaps that have been identified from the literature that have been reviewed for this research study.

Pittaway et al. (2004) reviewed network intermediaries and concluded that several gaps were found in the literature and that further exploration was needed that looked at the relationships between networking and different forms of innovation and in particular the role of third parties as they put support networks like professional trade associations and regional networks in the life sciences. Pittaway et al. (2004) looked at the extent to which UK companies engaged in networking activities when seeking to develop their innovative capacity. They examined the networking, relational ties or social capacity of companies located within clusters. There is a gap in the literature and Pittaway et al. (2004) and Coeurderoy and Duplat (2008) made a call for future research to examine in more detail the networking activities between companies and LSIs, which has not been done before.

Gassman, Daiber and Enkel (2011) said that the role that LSIs played needed further investigation. Abbate, Coppolino and Schiavone (2013) suggested examining the different brokerage roles in the transfer of knowledge and Brenner, Cantner and Graf (2011) suggested exploring the role of clustering and knowledge networking.

Suvinen, Konttinen and Nieminen (2010) who studied the optoelectronics and biotech sectors in Finland believed that if the triple helix model functioned efficiently in a regional or national innovation system there would be no requirement for intermediaries, which conflicts with the conclusions of Hendry and Brown (2006), who studied UK biotech clusters, that small biotech companies would probably not survive without the LSIs.

Dalziel's (2010) call for future research into the survival aspects of innovation intermediaries will hopefully be explored in relation to RQ3 (see below).

This PhD study will help us to understand better the impact that LSIs may have on a cluster of LS companies. The research questions identified for this research are:

RQ1. Are LSIs important for the commercialisation of research?

RQ2. What are the key perceptions and expectations of the KEC value that LSIs hold?
RQ3. Why do some LSI fail to survive beyond their funding stream?

RQ4. How important is an anchor organisation to a LSI?

These research questions have arisen from the literature as gaps in the knowledge relating to innovation intermediaries.

3.9 Terminology

Completion of this literature review has been prolonged by the issue of semantics. This was due to the multitude of terminologies used to describe the various organisations that operate as bridging organisations. This section examines some of the terminologies used within the literature search for this PhD research study.

The terminology highlighted in this section is only a proportion of that found in the literature. This search produced papers from literature on network dynamics. Many like Freeman (2009), Hagedoorn and Cloodt (2003), Hagedoorn (2002), Saxenian (1991), Mowery and Rosenberg (1989), Oliver and Liebeskind (1997), Swan and Scarbrough (2005) and Callon et al. (1991), have looked at the dynamics between networks of firms working in high-tech clusters, although not specifically in the life science sector. Their research is valuable in providing insights into inter-firm relationships. However there are also a number of researchers who have written extensively about the life science sector, in particular the biotechnology sector. They include Powell, Koput and Smith-Doerr (1996), Powell (1998), Powell et al. (2002), Owen-Smith and Powel (2004) and Saviotti and Catherine (2008) who have all written extensively about inter-organisational collaborations and the impact it has had on the commercialisation outcomes of biotechnology firms. All of these researchers have provided depth and insight into the still only relatively new biotechnology sector.

Finally the search focused on the term intermediary. This revealed many new streams of terminology used in describing intermediaries, most of which have been discussed within this chapter. The aim of this section is to provide a synopsis of the terminology on intermediaries within the life science sector.

Howells (2006), Lopez-vega and Vanheverbeke (2010), Dalziel (2010) and Coeurderoy and Duplat (2008) all use the term innovation intermediaries in their research studies. An innovation intermediary is defined as: '*individuals or organisations providing the bridging function in a high-tech setting'*. Their research has provided rich literature on the nature and role of an innovation intermediary, which has helped to inform this research on LSIs.

Other researchers who have used terminologies to describe an intermediary include Yusuf (2008) who discusses the working of four different types of intermediaries including universities which he categorises as 'a general purpose intermediary'. Yet another terminology is Technology Transfer Intermediaries which is another name for a technology transfer office (TTO) that Pollard (2006) uses. The role of 'bridging institutions' in sectoral systems of innovation is discussed by Hargadon and Sutton (1997), Howells (2006) and Sapsed, Grantham and DeFillippi (2007) and is yet another name for an intermediary. These bridging institutions are helping to bridge the divide between networks from a variety of organisations including SME's, Pharmaceutical companies and PROs like universities and research institutes. They are also given the name 'boundary spanners' as they work between organisations that do not usually overlap (Wright et al. 2008, Levin and Cross 2004, Kostova and Roth 2003). Metcalfe (2010) uses the term interstitial organisations to describe intermediary and intermediate functioning organisations. These organisations are intentionally situated between the state, industry and high education, which feature in the triple helix model that was discussed previously in this chapter.

The terms ‘broker’ and ‘gatekeeper’ are used to describe both individuals and organisations that operate between users and producers in brokerage or intermediary relationship (Sapsed, Grantham and DeFillippi 2007, Schiffauerova and Beaudry 2012, Abbate, Coppolino and Schiavone 2013, Stuart and Sorensen 2007, Obstfeld 2005). ‘A technology broker’ is an individual or organisation who brings together two disparate pieces of knowledge to create a novel technology (Stuart and Sorensen 2007). In addition ‘knowledge broker’ is yet another variation on the term ‘broker’. Malecki (2010) and Howells (2006) describe ‘knowledge brokers’ as a key catalyst in knowledge regions, who build bridges among people and ideas.

Further additions include, Stuart and Sorensen (2007) who used the term “Value-added intermediary” to describe biotechnology firms which they say act as intermediaries between universities and pharmaceutical firms. They show that biotech firms behave like intermediaries as they occupy the middle within a LS tripartite alliance structure. This is the case for biotech companies which have good connections both upstream with universities and downstream with pharmaceutical firms. While this may be the case in the USA, it has not been shown in other parts of the world (Stuart and Sorensen 2007).

‘Knowledge networks’ are described as intermediaries who provide engagement between academia and practitioners (Hughes and Kitson 2012, Nutley, Walter and

Davies 2007, Davies, Nutley and Walter 2008, Owen-Smith and Powell 2004). Knowledge networks are usually sector specific and involve a range of actors working in a specific area. Hughes (2011) looked at formal and informal knowledge networks, the formal ones tended to be fee paying while the informal ones were free.

There is no doubt that the plethora of terminologies used in describing intermediaries can cause confusion. This issue will be encountered by policy makers, practitioners and other researchers in the field and therefore the use of standardised terminology should be considered within the sector to assist with the sourcing of information. Table 3 was created from the typologies used within the literature on intermediaries reviewed for this research and represents only some of the terminologies from within the body of literature.

Table 3: Confusing Terminology

Terminology Used	Author and Publication
Association	Hughes 2011
Boundary spanning organisation	Wright et al. 2008, Levin and Cross 2004, Kostova and Roth 2003, Lee and Ohta 2010
Consultancies	Billington 2010, Lopez-vega and Vanheverbeke 2010, Wright et al. 2008
Faraday Partnerships,	House of Commons Science and Technology Committee 2011, Howells and Edler 2011
Fraunhofer Institutes	Mina, Connell and Hughes 2009, Howells and Edler 2011
Gatekeeper or broker	Sapsed, Grantham and DeFillippi 2007, Schiffauerova and Beaudry 2012, Abbate, Coppolino and Schiavone 2011, Stuart and Sorensen 2007, Obstfeld 2005
Intermediary	Shohet and Prevezer 1996,
Intermediary Technology Institutes (ITI)	Papaioannou 2009, Rosiello 2007
Innovation Incubator/Bio-Incubators	Lopez-vega and Vanheverbeke 2010, Yusuf 2008, Cooke 2002a, Huggins, Johnson and Steffenson 2008
Innovation intermediaries	Howells 2006, Lopez-vega and Vanheverbeke 2010, Coeurderoy and

	Duplat 2008, Daziel 2010, Dalziel and Parjanen 2011, Wilson 2012
Innovation network	Smedlund 2006, Malecki 2010, Saviotti and Catherine 2008, Owen-Smith and Powell 2004
Knowledge broker	Malecki 2010, Howells 2005
Knowledge brokerage organisation	Abbate, Coppolino and Schiavone 2011
Knowledge intermediary	Hughes 2011, Nutley, Walter and Davies 2007, Davies, Nutley and Walter 2008, Owen-Smith and Powell 2004
Knowledge network intermediary	Hughes 2011; Nutley, Walter and Davies 2007; Davies, Nutley and Walter 2008; Owen-Smith and Powell 2004
Networks	Malerba 2006, Powell 1998, Hendry and Brown 2006
Product Development Partnerships	Chataway et al. 2007
Regional network	Iles and Yolles 2002
Research and technology Intermediary	Mina, Connell and Hughes 2009
Sciences parks/Research parks	Wright et al. 2008, Etzkowitz 2003, Huggins, Johnson and Steffenson 2008
Technology Innovation Centres/Catapult Centres	Hauser 2010, House of Commons Science and Technology Committee 2011, Howells and Elder 2011, Reid et al. 2010, Wilson 2012
Technology transfer office (TTO)	Meyer 2010, Siegel, Westhead and Wright 2003, Ward, House and Hamer 2009a, 2009b, 2009c, Lee and Ohta 2010, Huggins, Johnson and Steffenson 2008
Think tanks	Meyer 2010
Value-added intermediary	Stuart and Sorensen 2007

This table shows the range of terminologies used in describing intermediaries for this research in alphabetic order.

3.10 Conclusion

This is a long and detailed chapter that reflects the literature that was reviewed for this research. The chapter starts off by asking about and where LS innovation comes from. There is an explanation of the knowledge transfer and exchange (KT & E) process and then the different types of knowledge and the different ways it can flow. There is a discussion on tacit knowledge exchange and open innovation models.

The chapter then moves on to a review of the literature that relates to LSIs, like TTOs, incubators, science parks and Catapult Centres all of which are explored in this research study. There is then a review of other LSIs that are currently operating in the LS sector and some past LSIs that have come and gone.

The literature review then moves forward to look at the various past studies relating to various theoretical concepts in order to show what has already been studied and what may need validating or identifying through a gap analysis.

The review on GTM research that has relevance to the sector, helps to justify the trajectory of this research. The subsequent gap analysis helps to show why GTM was chosen. The chapter concludes with a discussion on terminology and some description of the difficulties encountered while doing the literature searches due to a confusing terminology landscape. The researcher hopes that her call to standardise the terminology will lead the reader to understand why she created the new terminology LSI, which will provide a collective name for the intermediaries within the LS sector.

Chapter 4 Methodology and Research Methods

4.1 Introduction

4.1.1 *The Aims and Objectives of the Research*

Innovation has been identified as an important source of economic wealth (Lambert 2003, Hauser 2010, Wilson 2012). Innovations that emerge from the life science sector have a potential to help create economic wealth by creating new companies, employment, inward investment and products that can be sold globally. This market runs into billions of pounds and because of this, it has become a priority sector for many nations globally.

There is a belief that intermediaries can help in the drive to prosperity by bridging the divide between sectors, including producers and users of knowledge and over a number of years many have committed to this belief (Hauser 2010). The continued investment into intermediaries requires research in to whether they are as effective and valuable as perceived. This PhD research study aims to develop theories based on the evidence gathered of the value of a range of life science intermediaries from across the UK and with data from Holland and France for comparison purposes. This can potentially help to inform policy and funding decision-makers of the effectiveness of LSIs.

4.1.2 *The Research Questions*

This research has a focus on the role of the knowledge exchange and commercialisation (KEC) processes that take place within the different intermediaries. This is crucial in understanding their overall value in terms of economic and societal benefits. In order to decipher their KEC potential a closer look at the relationship between the LSIs and the actors within the networks in which they operate will help to determine the level of KEC operating within each intermediary.

Four main research questions for this PhD project have been developed based on the review of the related literature.

RQ1. Are LSIs important for the commercialisation of research?

RQ2. What are the key perceptions and expectations of the KEC value that LSIs hold?

RQ3. Why do some LSI fail to survive beyond their funding stream?

RQ4. How important is an anchor organisation to a LSI?

As discussed in chapter 1, these research questions were inspired by the literature on innovation intermediaries. The study by Suvinen, Konttinen and Nieminen (2010) looked at innovation intermediaries operating in two different sectors, biotechnology and optoelectronics in Finland. Suvinen, Konttinen and Nieminen (2010) had discussed the issue of 'Sectoral Systems of Innovations (SSIs) in their research paper and like Malerba and Orsenigo (2002) concluded that SSIs differ significantly in each sector and they recommended that future research projects should consider comparing sector-specific intermediaries, which has been done in this PhD research study.

This section will delve into how and why the RQs have been derived plus their importance to the research study as a whole.

RQ1. Are LSIs important for the commercialisation of research?

This question was asked in a similar way to that in Suvinen, Konttinen and Nieminen's (2010) paper. The research compared two intermediaries from two different clusters, one in Optoelectronics and the other in Biotechnology. At the time of reading this paper, the KEC movement across intermediaries had been initiated by the BBSRC. This led to the researcher wanting to investigate the value of LSIs in the commercialisation process.

This RQ is linked to research on Open Innovation research. The idea is that there will be more interactions between industry and academia that will lead to commercialisation outcomes.

RQ2. What are the key perceptions and expectations of the KEC value that LSIs hold?

This question arose through discussions with other academics. The idea of the expectation gap emerged from all these discussion. The researcher had been articulating the question differently until she discovered that it was used in the accounting literature specifically in audit work. The researcher believed that answering this question could possibly lead to a greater understanding of why so many of the UK LSIs were deemed as failures.

The researcher understood the basic financing of an LSI, having previously managed a couple of LSIs herself. Public money is handed over and there is certain expectation from the funders that the targets set will be achieved.

RQ3. Why do some LSI fail to survive beyond their funding stream?

This question is about the LSIs that are considered to be successes. Why do some of the LSIs survive and thrive beyond their funding period? This research will try to understand what they do differently that allows them to continue operating.

RQ4. How important is an anchor organisation to a LSI?

This question emerged via the literature, including Hendry 2006, however, only after the first interview had taken place.

The first interview was at the Stevenage Bioscience Catalyst based on the grounds of a GSK, a large pharmaceutical company. The researcher was curious about the impact the proximity to such an anchor had on the LSI. Later the researcher built this question into all the different LSI questionnaires.

RQ3 and RQ4 were identified and included along the research journey, and were therefore late additions. They have been included as the researcher believes they will be important in answering the overarching question of this research study: of what impact do LSIs have on KEC. They help to create a better overall picture of the Case LSI models, allowing for comparisons between those LSI, which in the Case of RQ4, have an anchor and those that do not.

This chapter will review the methodology chosen for this PhD study. The research is placed within the interpretative paradigm and is therefore a qualitative research study. There is some detailed discussion on the overarching Grounded Theory Methodology (GTM) and the Constructivist Grounded Theory (ConGT) approach that has been followed. This chapter follows a logical flow and justification for decisions and philosophical assumptions that are included along the way.

4.2 Research Paradigm

The research paradigm is the overarching framework that helps to define and guide the study (Collis and Hussey 2003, 2009). A research paradigm is defined as:

> *"A framework that guides how research should be conducted, based on people's philosophies and their assumptions about the world and the nature of knowledge" (Collis & Hussey 2009, p.55)*

In science and philosophy a paradigm is simply a term to explain how we perceive the world. It was Thomas Kuhn would made the term scientific *paradigm* fashionable by adopting the word to refer to a set of concepts and practices that define a scientific discipline. He explained that a scientific paradigm is a framework containing the basic assumptions, our perception or way of thinking of the world and methodology that are commonly accepted by members of a scientific community. There was only one research paradigm for many years and this was found in the natural sciences (Kuhn 1962). Kuhn's seminal book '*The Structure of Scientific Revolutions'* (1962) discusses the history of scientific revolutions, the domination of the natural sciences and the paradigm shifts that brought forth new ways of thinking and new paradigms.

> *"The successive transition from one paradigm to another via revolution is the usual development pattern of mature science" (Kuhn 1962, p.12).*

A paradigm shift will emerge as a response to a build-up of critical differences and when a new model is proposed. Kuhn provides examples of how this shift happened within different sciences, which he uses to justify the shift away from the natural sciences. Within the natural sciences, the methods used employ observation and experiment which means they observe the nature of discoveries and establish an understanding of why they have emerged (Kuhn 1962, p.57, Carey and Smith 1993, Collis and Hussey 2009). The paradigm of the natural sciences sits in the realm of the positivists, which has its roots in the philosophies of realism (Collis and Hussey 2009).

This shift in scientific thinking led ultimately to the development of a second research paradigm, that of the social sciences. Initially the new social sciences followed methodologies used in the paradigm of the natural sciences, however it soon became clear that the methods employed did not allow for discovering meaning within the social world and did not fit well with the social sciences paradigm, as they were based on observation and measurement. In due course the social sciences developed methods based on an interpretivist stance, which can be thought of as opposite to those of a positivist paradigm (Collis and Hussey 2009).

A few years after Kuhn had written his seminal book on ‘The Structure of Scientific Revolutions’ (1962), another important social sciences argument came to the fore: that of the ‘Social Construction of Reality’ which was first introduced by Berger and Luckmann in 1966. Their work was greatly influenced by Schutz’s work on phenomenological approaches to sociology. In fact Berger and Luckmann’s work was actually a continuation of Schutz’s work that led to the breakthrough work done by Berger and Luckmann in better understanding human culture and reality that they defined it as the ‘The Social Construction of Reality’ (Berger and Luckmann 1966, Holstein and Gubrium 2008). The Social Construction of Reality has stimulated a vast swath of research in the social sciences and this PhD Research Study has also been influenced by it. We will discuss this further later in this chapter.

4.2.1 *Interpretivism and Positivism: The two main paradigms*

Positivism used in the natural sciences utilises more ‘scientific’ methods. These methods are also regularly used in the social sciences, alongside the new interpretivist based methods. A researcher will need to clarify the paradigm that the research sits within before the research starts. The two main paradigms are positivism and Interpretivism, they are positioned at either end of a spectrum along which there are many other paradigms that forms a *“continuum”* of paradigms as described by Morgan and Smircich (1980), which move between positivism and Interpretivism.

Positivism as mentioned previously has its roots in the natural sciences, where introspection and intuition are rejected. What is important to positivists is to gather data that can be observed and measured.

> *"Positivism is a paradigm that originated in the natural sciences. It rests on the assumption that social reality is singular and objective, and is not affected by the act of investigating it. The research involves a deductive process with a view to providing explanatory theories to understand social phenomena." (Collis & Hussey 2009, p.56)*

> *"Every rationally justifiable assertion can be scientifically verified or is capable of logical or mathematical proof." (Walliman 2001, p.15)*

Interpretivist assert that social reality is subjective rather than objective and is shaped by our own understanding of reality.

> *"Interpretivism is a paradigm that emerged in response to criticisms of positivism. It rests on the assumptions that social reality is in our minds, and is subjective and multiple. Therefore, social reality is affected by the act of investigating it. The research involves an inductive process with a view to providing interpretive understanding of social phenomena within a particular context." (Collis & Hussey 2009, p.56)*

Many researchers (Collis & Hussey 2009, Morgan and Smircich 1980, Kuhn 1962*)* make a distinction between the two types of paradigms, positivism is positioned in the natural sciences and interpretivism in the social sciences, although, as mentioned previously, researchers can also carry out positivistic research within the social sciences.

4.2.2 *Considering The Researcher's Philosophies*

In order for a paradigm to emerge the researcher must first consider their own views and position on the epistemological, ontological and methodological properties of the research they wish to undertake. All of these different components are connected, (Guba and Lincoln 1994). Therefore, how we decide on what methodology to use for our research is influenced by the ontology and epistemology within which the researcher has positioned the research, and it is therefore important to understand each of the three components before making that decision.

The epistemological stance involves the relationship between the researcher and what is being researched. This is about the researcher's basic belief about knowledge or "how we know what we know" (Crotty 1998). The word epistemology derives from the Greek '*knowledge about knowledge'*. With a quantitative paradigm the researcher endeavours to be detached and independent of what is being studied, while in the interpretive paradigm the researcher is encouraged to take a more interactive stance through participation or observation (Creswell 1994), thereby decreasing the distance between the researcher and what is being researched (Collis and Hussey 2009).

The Ontological stance is concerned with the nature of reality – the central part of the phenomenon under investigation. The researcher needs to consider the two approaches, which are objectivist and subjectivist. Positivists believe that reality is objective and external to the researcher and therefore there is only one reality. Interpretivist believe that social reality is subjective because it is socially constructed. Therefore each person has his or her own sense of reality and there can be multiple realities (Lincoln and Guba 1985, Collis & Hussey 2009)

The Methodological stance is concerned with the processes used in the research. If you are a positivist researcher you will focus on objective facts and formulate hypotheses. Your analysis will look for associations between variables and or causality, where one variable may affect another. An interpretivist would examine a small sample over a longer period of time. A number of different research methods will be used in order to gain different perceptions of the phenomena. During the analysis stage patterns within the data will be explored that have the potential to be repeated in different situations (Collis and Hussey 2009).

It is paramount that the researcher fist considers the epistemological stance and their ontological stance, as both will lead to the best methodological stance for the research and therefore which research paradigm the research aligns with.

Table 4: The Two Main Research Paradigms

Assumption/Stance	Positivism	Interpretivism
Epistemological **(what constitutes valid knowledge)**	The researcher is independent of that being researched	The researcher interacts with that being researched
Ontological **(that nature of reality)**	Reality is objective and singular, separate from the researcher	Reality is subjective and multiple, as seen by the participants
Methodological **(the process of research)**	The process is deductive Focused on objective facts and formulate hypotheses. Results are accurate and reliable through validity and reliability.	The process is inductive Study of emerging design that leads to the identification of categories during the research process. Patterns and theories are developed for better understanding Findings are accurate and reliable through verification

Adapted from Creswell (1994, 1998), and Collis and Hussey (2009)

Table 4 explores the different aspects of the two main paradigms of positivism and Interpretivism. Reviewing the researcher's stance pertaining to their understanding of what constitutes knowledge, the world around them (reality). The processes they feel would suit these areas are outlined by the table and can help the researcher make choices relating to the phenomenon under investigation.

Researchers who have chosen a positivistic paradigm must deal with issues pertinent to the methodology such as: sample accuracy, reliability, validity of measures and generalisability. Researchers who have chosen an interpretive paradigm must deal with more fundamental issues, these include: argument and justification on what constitutes reality, the validity of the chosen paradigm. They need to debate epistemological questions about the relationship between the knower and what can be known before even getting to the methodological issues (Lee, Saunders and Goulding 2005). The complexity of the issues that must be addressed in the interpretivist paradigms has led many business and management researchers to choose a positivistic methodology (Shanker and Goulding 2001).

Generally researchers believe that a positivist paradigm applies to quantitative methodologies, while the interpretivist paradigm applies to qualitative methodologies that are not derived from quantitative data (Strauss and Corbin 1997, Creswell 1994, 1998). However, research is not always clear cut, both quantitative and qualitative methods are often used in the same paradigm (Table 5). The use of more than one method like this is known as mixed methods. This allows for triangulation of the data, which is believed to add viability and reliability to the research process (Denzin and Denzin 1978, Guba 1990, Collis & Hussey 2009). Carey and Smith (1993) also says:

> *"In quantitative research facts act to constrain our beliefs, while in interpretive research beliefs determine what should count as fact." (Carey and Smith 1993, pp.245-246)*

As mentioned previously the paradigm chosen will determine the researcher's methodological stance. Table 5 compares the main features of the two main paradigms and details the methods and instruments used for data collection/generation, common to both. This more holistic view helps to place the research within the paradigm that best suits the research and that of the researcher's philosophical assumptions.

Table 5: Features, Methods and Data Collection Instruments for the 2 main Paradigms

Paradigm	Positivism/Quantitative	Interpretivism/Qualitative
Features	Use of large samples Use artificial locations Focused on hypothesis testing Produces specific, objective quantifiable data reliability is high but validity is low Results can be generalised from sample to population	Use of small samples Use of natural locations Concerned with generating theories Produces rich, subjective qualitative data Low reliability but high validity Results can be generalised from one setting to another
Methods	Quantitative methods predominantly, but qualitative methods can be used	Qualitative methods predominantly, although quantitative methods may be utilised
Data collection instruments	Surveys Experimentation Questionnaires Testing measuring Scales	Interviews Observations Document analysis Visual data analysis

Source: Adapted from (Collis & Hussey 2009, Mackenzie and Knipe 2006)

For this study the researcher will take an interpretivist stance and utilise a qualitative methodology. The instruments that will be used to collect data will be those that fall within the qualitative research methods. These include interviews, observations and document analysis. The sections below discuss the pathway to these choices and the justification for them.

4.3 Research Methodology

The research methodology is the central framework and is determined by philosophical assumptions and the methods chosen (Duberley, Johnson and Cassell 2012). It is important that a researcher chooses a research methodology that relates to their understanding of reality (Guba 1990). This means they must decide on the paradigm in which the research sits.

The research paradigm will impact on the researcher's choice of methodology and methods for collecting and analysing the research data (Hussey and Hussey 1997). There is a huge range of both methodologies (Table 6) and methods (Table 5) to choose from. Consideration of the researcher's background, their skills and experience, how the researcher will engage with the phenomenon, the nature of the phenomenon itself and finally the audience to whom the research will have relevance to, should be reviewed carefully (Creswell et al. 2003).

Choosing the right methodology can take time to get right. The researcher should shortlist a number of suitable methodologies and carry out an in-depth review of each of them before making a decision.

Table 6: The main methodologies used within the discipline of business and management.

Positivism *Continuum of Paradigm*	**Interpretivism**
Methodologies	
Experimental studies	Hermeneutics
Survey's (using primary or secondary data)	Ethnography
Cross-sectional studies	Participative enquiry
Longitudinal studies	Action research
	Case Studies
	Grounded theory research

	Feminist, gender and ethnicity studies

Source: Collis & Hussey (2009)

4.3.1 *The Research Position and Factors Influencing that Choice*

After careful consideration of the ontological, epistemological and methodological stances pertaining to this research phenomenon, as outlined in Table 5, the researcher concluded that this PhD research fell within an interpretive paradigm and would follow a qualitative methodological approach.

4.3.2 *The Philosophical Justifications and the Link to the Phenomenon*

The Triple Helix was considered, however the research carried out by Suvinen, Konttinen and Nieminen (2010) outlined some of the weaker aspects of this methodology and their challenges in trying to use it to answer their research questions (see the sections 3.6.1 and 3.8). As was discussed in section 3.6.1, the Triple Helix methodology does not work well in studies that are focused on Sectoral Systems of Innovation and Regional and National Innovation Systems.

Other methodologies considered include the Actor Network Theory and Case Study Theory. Both of these methodologies would require an in-depth knowledge of each of the LSIs being explored. The level of access to the individual LSI organisations required was not available in this study.

4.3.3 *The Argument against Case Study Methodology*

The researcher had initially intended to use a Case Study methodology in this PhD study. She explored past research pertaining to LSIs (as seen in Chapter 3, section 3.6), and discovered a paucity of research using Case Study methodology in the literature to answer specific question like the 4 RQs identified in this study.

Eisenhardt (1989) says that central to theory building in Case Study research is replication. She explains that each case is its own unit and is able to be analysed as such. Case Study research also provides a holistic view as a detailed picture of the case organisation is built up from a number of different sources (Yin 1994). This all sounded promising at the initial stages of this research study.

Eisenhardt's 1989 paper makes 2 contributions to the academic literature, the first was to build a roadmap for extracting theory from Case Study research, and the second was in positioning theory building from Case Study research into the social science research arena. Her paper explored strengths and weaknesses of theory building from Case Study research.

On further review, both GT and Case Study methodologies start off the same way: by identifying the RQs normally. For the Case Study research these are extracted from available literature in the substantive area. In the traditional GTM there are RQs, however there is normally expected to be scant literature. Again this would work for this PhD study as there is literature available on the substantive area although there is there scant theory in the literature as is the case for this research study (Harrison and Leitch 2000). These two methodologies required time to analyse the different processes in each in order to apply the philosophical justification required. The question was which methodology should be used as the primary one?

As previously discussed it did appear initially that the Case Study methodology could be applied to the this PhD study and there had been previous research within the University group under Professor Kouhy who had successfully carried out a case comparison using a Grounded Theory Methodology, hence expertise within the group.

On researching GTM a number of different approaches were uncovered and one of these allowed for the researcher to have experience of the phenomenon under investigation and allowed the RQs to be identified through available literature (see section 4.1.2 for details on this). Therefore although Case Study research allows for extant literature and traditional GT does not, the new identified approach meant that a wholly GT methodology could be applied. Another major negative was Eisenhardt and Graebner's (2007) claim that Case Study research does not always come close to answering the RQs.

Other reasons for deciding against a Case Study methodology are that the bottom up approach required, produces theory that is generalizable and this PhD study is sector specific and focused, and therefore not generalizable (Eisenhardt 1989, Malerba and Orsenigo 2002). This means the theory will only apply within the life sciences sector. The second reason is that this methodology results in overly complex empirical data being produced. The volume of data created impacts on the theory, and by using all of the data in theory building it becomes unwieldy.

> *This could therefore produce theory rich in detail, but would lack the simplicity of the overall perspective (Eisenhardt 1989, p.546).*

Another reason for not choosing the Case Study methodology was that much of the process defined by Eisenhardt in her 1989 paper include methodology drawn from GT, where the data collection methods include theoretical sampling, saturation, coding and analysis (Eisenhardt 1989, p.546). Eisenhardt (2007) says that a close location to the unit under study reduces bias and keeps the researcher honest, this is also achieved in GTM as memo taking is an integral part of the process and memo-taking allows the researcher to remain close to the data and reduces any bias. However, the main reason for this decision is that the Case Study research framework proposed by Eisenhardt takes a definite positivist view, whereas this PhD study sits is in the realm of the interpretivist (Eisenhardt 1989, p.546).

4.3.4 *The Argument for GTM*

This PhD research will follow a Grounded Theory Methodological (GTM) approach throughout with the intention of generating theory. GTM is one of the methodologies that falls within the interpretive paradigms (Table 6), and best fits with the research envisioned. The selection of GTM has come about after a detailed review of a number of other research methodologies that could fit with the researcher's philosophies.

This PhD project did however allow for a comparison between the LSIs and this was one justification for choosing a GTM.

In addition GTM can provide rigour and a systematic process and analysis, while permitting flexibility and freedom to explore the phenomenon and allowing for the emergence of any issues (Bryant 2002, Glaser 1978, Jones, Coviello and Tang 2011). Moreover, GTM has been chosen as it allows for theory to develop and emerge from the research, where there was none previously.

The researcher considered the issues carefully before deciding on the appropriate theoretical methodology for this research, as there has been extensive research using a range of methodologies on many aspects of the life sciences sector. The literature on GTM is divided when it comes to researching a previously well explored area. Strauss and Corbin in their 1994 paper claimed that GTM had the ability to generate novel and exciting ideas about issues that have already been heavily investigated. O'Reilly, Paper and Marx (2012) says that GTM should not be chosen if the phenomenon has been heavily researched. However, they also say that if the existing literature does not adequately explain the phenomenon then you can use GTM to develop new theory. The researcher also had to decide if prior knowledge and experience of the sector in which the phenomenon was located would jeopardize the theory development stage of the research. However, found that providing the researcher remained open to the data collected and avoided introducing bias based on pre-existing assumptions, it is possible to generate new theory based on the data collected (Goulding 2002, O'Reilly, Paper and Marx 2012). The use of Memos throughout the study process helped to reduce the element of bias and opened the researcher to new pathways that led to potentially novel theory. There is an argument that supports this reasoning: if the researcher has previous practical and theoretical experience of the phenomenon it should be viewed as an asset rather than as a liability (O'Reilly, Paper and Marx 2012, Fendt and Sachs 2008). This is because in order to make judgements on theoretical saturation a deeper understanding of the field through active professional experience will enable the researcher to know when the saturation point has been made, therefore prior experience can benefit the research (Goulding 2002, Finch 2010). Based on this review of the issues it was decided that applying a GTM methodology was fully justifiable.

There are many unanswered questions regarding the lack of success of the UK life sciences sector, and this study seeks to address some of these. The researcher has only identified a limited number of studies looking at LS intermediaries. The study carried out by Lopez-vega and Vanheverbeke (2010) has already been discussed in Chapter 3 under Past Studies using GTM. They explained how they used GTM to enable them to identify categories by simultaneously comparing the data collected during the analysis process.

To date, and to the researcher's knowledge, there has not been any research on a comparative analysis between different models of LSIs to explore their value in KEC. This paucity encourages the need for theory-generating approaches such as GTM to be considered (Idrees, Vasconcelos and Cox 2011, Mehmetoghu and Altimay 2006, Binders and Edwards 2010). GTM calls for an

> *"In-depth understanding of the phenomena where little is known and where the focus is on the participant's experiences and their interactions" (Glaser 1998, p.136).*

Lopez-vega and Vanheverbeke (2010) suggested that due to the complex and idiosyncratic nature of innovation intermediaries, use of a single literature to inform the phenomenon will not produce viable results. Investigating a range of LSIs and linking the literature on knowledge exchange and commercialisation and the extant literature will hopefully generate new theories that will add to the literature on innovation intermediaries especially the literature on the sector specific intermediaries like LSIs. The justification for choosing GTM is that this research adapts an inductive approach and will take into account the researchers prior knowledge of the sector and the current literature within the sector.

This is a summary of the key factors for choosing GTM (O'Reilly, Paper and Marx 2012, Goulding, 2002; Charmaz, 2006)

- The main objective is in theory building rather than theory testing
- The literature reviewed had no clear theories that could be identified for testing

- GTM is positioned within the Interpretivism paradigm (Table 6)
- GTM allows for a more holistic approach to data collection
- GTM allows for interaction and observation with participants, which fits the Interpretivism paradigm. (Goulding 2002)
- The researchers understanding and knowledge of the sector to be investigated is beneficial
- The amount of research already done in the LSI sector can be referred to

A number of researchers have advocated for the increased use of GTM in business and management research. This is because of the formalised structure of the methodology which means that itself rigorous and therefore provides greater validity (O'Reilly, Paper and Marx 2012). Moreover, the method allows for a context-based description of the phenomenon to be developed (Myers and Avison 2002)

Before moving on to the rationale for choosing to use GTM in more detail, a brief look at the evolution of Grounded Theory will help to illustrate the reasoning behind the decision. Once we have discussed the history and the different approaches to GTM, we will look at the justification for the choice of GTM approach for this research.

4.4 The Background to Grounded Theory (GT)

Grounded Theory as a new methodology was first developed and proposed by Glaser and Strauss (1967) as a response to the use of positivistic methodologies that were prevalent at the time in social sciences research. This new methodology was quite different to other methodologies that used a deductive (usually seen in quantitative methodologies) rather than an inductive means for collecting and analysing data – as was proposed in Classic Grounded Theory (CGT). Theory testing rather than theory generating also made CGT stand out. They believed that the traditional positivist methodologies used by social scientists were unable to effectively draw out meaning from the actors in social settings. They believed that methodical data collection could be used to develop theories that address the interpretive realities of actors in social settings.

In addition they believed that new theory could be built by observation and interaction with the actors in social settings for an inductive understanding of the phenomenon derived from the participants themselves (Charmaz 2006, Locke 2007, Suddaby 2006).

4.4.1 *The Hybridization of GT methods*

The prescriptive nature of GT allows researchers to choose to follow different methodologies, while using GT methods in their research. This hybrid use of GTM methods has been encouraged more recently (Annells 2006, Birks and Mills 2011). Although initially it was known as '*Methodology muddling'* (Baker, Wuest and Stern 1992) and was frowned upon (Locke 1996), this has now changed, and it is accepted for researchers to use GT alongside other methodologies, although they must justify this hybridisation (Wilson and Hutchinson 1996, Lee, Saunders and Goulding 2005). The use of GTM must of course fit with the researcher's methodological goals and philosophies to ensure the successful completion of the research.

Besides this hybridisation where the GT methods are used with other methodologies, GT methods has also been used in Mixed Methods research projects. This is where the researcher uses both qualitative and quantitative methodologies (Wells et al. 2008). GT methods have been used successfully in these mixed methodology study too (Birks and Mills 2011) and is seen as one of the strengths of GTM.

4.4.2 *Approaches to Grounded Theory*

It has been five decades since Grounded Theory (GT) was introduced to the world as a new methodology in 1967 by Glaser and Strauss. It is then not surprising that GT has undergone a number of iterations.

Initially both Glaser and Strauss spent time delivering seminars on GT. However, they found it difficult to convey the essence of the methodology to students and colleagues, as this new methodology went against all the common methodologies used by social scientists (Glaser 1978).

Researchers new to GT found the concepts difficult to understand and to apply. As a response to these difficulties Glaser wrote a book called *Theoretical Sensitivity* (1978), where he hoped to explain more on how theory can be built. Unfortunately this new book did little to reverse the problem, and it still proved too difficult and left unresolved the main issues faced by novice researchers. Glaser said that in order to successfully do GT the researcher would need to become an expert in conceptualisation, but most researchers have no training to allow them to do this (Glaser 2001).

In 1990 Strauss also published a book called *Qualitative Analysis,* again in the hope of addressing the issues that novice researchers to GT had with the methodology. Then in 1997 Strauss along with Corbin published their booked called *The Basics of Qualitative Research,* which added to the GT methodology. They believed their approach was more prescriptive and structured and therefore addressing one of the issues with the original approach, particularly for novice researchers. They provided a definitive structure that needed to be strictly followed that would eventually lead to theory generation. The Strauss and Corbin version of GT is known as Straussian GT (SGT).

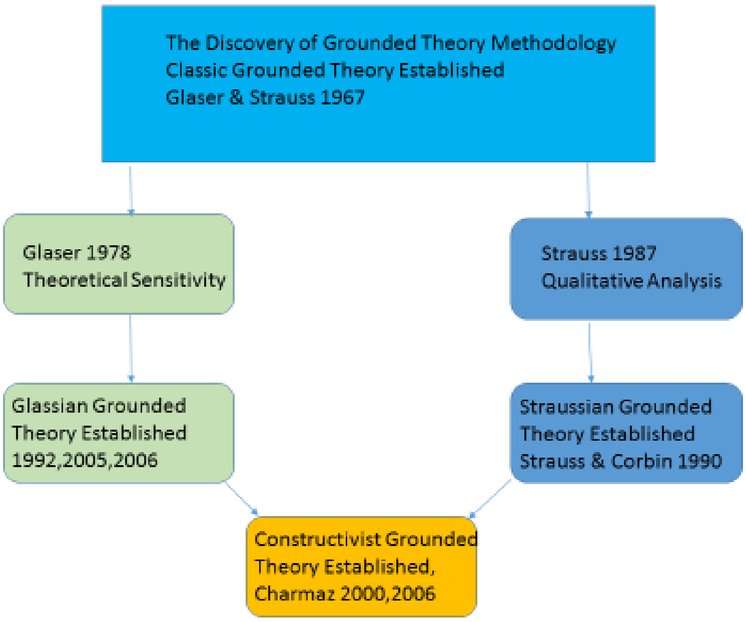
This new approach caused a rift between Glaser and Strauss. Glaser thought that this addition to the methodology endorsed the ‘forcing’ of theory generation as argued in his published book The Basics of Grounded Theory Analysis: Emergence v Forcing (1992). Another major divergence between Glaser’s and Strauss’s different approaches is that Strauss and Corbin encourage the researcher to consult the literature and be influenced and guided by it, whereas Glaser prescribes that the researcher should not consult the literature as preconceptions will emerge that will have an impact on theory generation.

Although the debate continued between the two founding fathers of GT, the use and strength of GT continued to grow and evolve. There are now numerous approaches that have been proposed, mostly by students of the two founding fathers, the list of researchers include: Bowers 1989, Clarke 2005, Charmaz 2006, Ghezeljeh and Emami 2009, and Morse 2009. They believed that GT was still too positivistic and have shifted it towards the interpretivist side.

These various approaches have added to the time that a researcher needs to take in order to choose the best approach. All these approaches are known as GT and the researchers have to familiarise themselves with each approach in order to decide which would best fit with the researcher’s epistemological and philosophical positioning (Suddaby 2006, Hunter et al. 2011, Birks and Mills 2011)

Constructivist GT, developed by Kathy Charmaz in 2006, has gained in popularity and has been compared with the GGT and SGT in Table 7 found later in this chapter. Each of the three different approaches are discussed and then finally compared in the next section.

Figure 6: The Three Main Approaches to GTM



The development of the three main approaches to grounded theory that emerged from the classic grounded theory, both sides gave rise to Constructivist GTM.

Source: This research

4.4.3 *The Classic and Glaserian Grounded Theory (CGT) Approach*

The original work by Glaser and Strauss in 1967 is considered classic grounded theory (CGT). Glaser has always defended this original methodology (Glaser 1978, 1992, 1998, 1999, 2003), and the central concept that discovery will lead to theory generation. From 1992 onwards CGT became known as Glasserian Grounded Theory (GGT). Glaser disassociated himself from Strauss, who he believed was promoting qualitative data analysis rather than grounded theory (Glaser 1998).

In the GGT approach the researcher does not start with the research question, as in more traditional methodologies, instead the focus is on the social area of interest within the phenomenon under investigation. GGT also recommends that a literature search is not carried out at the start of the research, this is to prevent any preconceptions that may be formed from the phenomenon under investigation (van Niekerk and Roode 2009). As previously mentioned Glaser has always defended the CGT methodology. One concept Glaser (1992) advocates is for the researcher to embark on the research with an 'open mind', which Dey (1999) equated to a researcher having an "empty mind". Glaser countered this statement by explaining that the researcher did not embark on the research journey with an "empty mind", instead with an educated open mind that was attuned to patterns and regularities within the social setting. This means that the researcher is guided by what he finds while doing the research, and the theory will become apparent as the research progresses.

In the original book on CGT by Glaser and Straus (1967) they presented the concept of theoretical sensitivity. Theoretical sensitivity is one of the main tenets of CGT. It was explained as coming in two parts, the first is based on the researcher's insights into themselves and the area they are researching and the second reflects their intellectual history and how they think about the area they are researching (Birke and Mill 2011). What this implies is that the researcher has the ability to extract meaning from the data as it relates to the emerging theory. This is probably linked to what Glaser refers to as the researcher having an “open mind” or as he argues later an “educated openness”. Birke and Mills (2011), discuss three key features of theoretical sensitivity, these are:

1. A reflection of intellectual history, both personal and professional
2. It can be enhanced by various techniques, tools and strategies
3. It will increase as the research progresses

Along with theoretical sensitivity there are four other important tenets that make up the analytical guidelines for GT. They are:

1. The constant comparative method,
2. Theoretical coding,
3. Theoretical sampling, and
4. Theoretical saturation.

These four analytical techniques make GT a unique methodology (Charmaz 2006). From the original work by Glaser and Strauss (1967, p.237) they laid out specifics for the analytical work that needed to be done and what the researcher should be looking for at the different stages.

1. Fit – is there a good fit between the substantive area and the theory?
2. Understandability – Will the theory be understood by lay persons?
3. Generalisability – will the theory apply to a wide range of situations in the phenomenon under investigation?
4. Control – is their control over structure and process over time?

GGT allows for research to be fluid, flexible and evolving in nature, which has many advantages over more traditional methodologies. In addition its strength lies in its ability to develop theory through the use of prescribed, yet flexible, tools that are used for analysis (Charmaz 2005).

Another advantage of this approach is that the researcher can collect data from multiple sources of data. This allows for increased validity and can provide a better explanation of the phenomenon. These different sources may include: interviews, articles, websites, newspapers and other media that relate to the phenomenon being studied. This new methodology wanted to help bring rigour to the processes and at the same time allow the researcher to interpret social meaning through rigorous consideration of the evidence. This can happen with multiple sources of data that are available and permissible within the methodology. The researcher has more evidence available in order to build concepts and explanations relating to the phenomenon (Hunter et al. 2011). GGT strategies are particularly suitable for research that take place in areas that are not well understood and have not been researched extensively (Hunter et al. 2011). This would have been an issue for this research study as the substantive research area has been extensively investigated.

4.4.4 *Straussian GT (SGT) - Strauss and Corbin's Approach*

The Straussian approach has, since its appearance in 1990, become very popular with a wide range of disciplines, including business and management and especially in healthcare research. In the SGT approach the two authors recognised that the researcher would have both their own professional experience and knowledge gained from literature they had reviewed on the substantive area; they understood this and incorporated it within their approach. This was a major divergence from Glaser's belief that the researcher should not engage with the phenomenon. Strauss and Corbin believed that engagement with existing literature would help the researcher identify various elements along the stages of the methodology, including reaching saturation points and identifying theory from the data (Strauss & Corbin 1990). The caveat was that the researcher must “maintain an attitude of scepticism” (Strauss & Corbin 1990) and not allow this to influence the theory that emerges.

In their book Basics of Qualitative Research: Grounded Theory Procedures and Techniques (1990), Strauss and Corbin took a more prescriptive formulaic approach to GT. There are a number of key differences between SGT and GGT approaches. One of the main ones is the addition of coding to the analysis stage and these additional coding stages are Open Coding, Axial Coding and Selective Coding. They presented eleven different procedures that the researcher would need to follow (Strauss and Corbin 1990), these procedures are as below:

1. Data collection are interrelated processes
2. Concepts are the basic units of analysis
3. Categories must be developed and related
4. Sampling in GT proceeds on theoretical grounds
5. Analysis makes use of constant comparisons
6. Patterns and variations must be accounted for
7. Process must be built into theory
8. Writing theoretical memos is an integral part of doing GT
9. Hypotheses about relationships among categories are developed and verified as much as possible during the research process
10. A grounded theorist need not work alone
11. Broader structural conditions must be brought into the analysis, whatever the size of the research

It is clear that SGT follows GGT to a point and includes many of the original procedures from GGT. However it is not just the addition of coding that makes it different. While both support sampling based on theoretical grounds as in point 4 of the list above, SGT allows the researcher to influence the phenomenon with pre-knowledge, while GGT states that it should come from the data and not the researcher.

Moreover, in GGT there is an abductive element to processes for identifying patterns and variations that emerge from the data. Abduction is a mix of both induction and deduction. The SGT approach has a focus on deductive processes and embedded verification. In SGT verification (Point 9 of list) is a continual process and is embedded within the entire methodology processes. This is a major difference in philosophies between the two methods. In GGT there is no element of verification built in to the process as Glaser believes that verification is part of quantitative research and not qualitative – although Rennie (1998) suggests that GGT has verification built-in, through the 'symbiosis of induction and abduction during the constant comparison of data*'.*

Many researchers find the SGT approach a little too structured and ridged, especially the need for extensive coding, which makes it seem less flexible than GGT. Moreover there is a focus on deduction, verification and validation. This has been defended by Corbin and Strauss in a more recent publication.

> *"Techniques and procedures are tools not directives. No researcher should become so obsessed with following a set of coding procedures that the fluid and dynamic nature of qualitative analysis is lost. The analytic process, like any thinking process, should be relaxed, flexible and driven by insight gained through interaction with data rather than being overly structured and based only on procedures." (Corbin and Strauss 2008, p12)*

4.4.5 *Constructivist Grounded Theory Approach*

Another researcher Kathy Charmaz (2000, 2006) proposed a more constructivist approach to GT that would incorporate a mutual understanding between the researcher and the participant. With the Constructivist Grounded Theory (ConGT) approach, the research lies directly within the interpretive paradigm of research. Although not intended both GGT and SGT have gained some recognition from quantitative researchers who have taken to using it in mixed methods studies because of its positivistic assumptions (Charmaz 2006). This was an unintended consequence and did not sit well with qualitative researchers because of the "objectivity" of the researcher. In both SGT and GGT it is assumed that the researcher's preconceived ideas are purged by use of the methods (Glaser 2002). This detachment of the researcher from the process is more related to a positivist paradigm than an interpretive one.

The Constructivist movement first introduced by Berger and Luckmann (1966) dictates that social constructivists deal mostly with 'what' people construct and the 'how' it is all explained. Charmaz states that the 'why' of Social Constructivism is not clearly explained and this is fundamentally why ConGT has emerged (Charmaz 2008, p.397) as all three of What, How and Why are embedded within the ConGT methodology. Her reasoning was that most qualitative research had not addressed these three questions before this.

GTM starts with an inductive strategy for collecting and analysing data that leads to theory development (Charmaz, 2008). One advantage of GTM is that the social continuance of the research participants is maintained while the researcher is carrying out his or her investigation. The GTM theorist is able to focus on the data gathering and analysing with the two questions at the heart of the research - 'What' and 'How'. Interacting with the substantive area allows for theory to emerge. A Social Constructivist approach to GT allows us to address the 'Why' questions while preserving the complexity of social life (Charmaz 2008, p.397). Charmaz developed the ConGT approach specifically to address the 'Why' question. She explained that the ConGT researcher develops his or her studies in a way that allows for greater explaining and understanding and allows for all three questions to be answered.

Glaser and Struass's more classic approach to GT adopts a less constructivist element than the ConGT approach outlined by Charmaz. Their methodology allows for generalisation and objectivity rather than the reflexivity and relativity found in CoGT (Charmaz 2008, p.399). Reflexivity is a key component of this constructivist revision and renewal of classic GT, and permits the research to be entrenched within the process, rather than separate to it (Charmaz 2008).

In ConGT the researcher is involved in the theory building. The logic here is that the researcher's understanding, interpretation and experiential learning, impacts on the theory that is created or constructed and considers knowledge to be constructed in nature and inextricably linked to the researchers interfaces with others and the environment (Lincoln, Lynham and Guba 2011). Unlike SGT and GGT, the researcher is not 'purged' from the process. In ConGT the theory generated will incorporate the researcher's views (Charmaz 2014).

> *"…it is not the research methodology that aims to discover a theory despite the researcher, but it is the researcher who aims to construct a theory through the methodology" (Charmaz 1990, p.1162)*

Charmaz (2006) explains that both GGT and SGT provide the building blocks for the research process and she brought the methodological assumptions from GGT into the twenty-century. She views GGT not as a prescriptive package, but as a set of principles and practices that allows for the many divergences.

The basis of the Constructivist approach is that concepts are constructed rather than being discovered. Unlike GGT and SGT in ConGT there is no assumption made that data and theories are discovered, and

> *"We construct our grounded theories through our past and present involvements and interactions with people, perspectives, and research practices" (Charmaz 2006, p.10).*

ConGT places much more emphasis on the people and participants than on the processes and the methods. However, saying that ConGT does still put some value to various practices, like data gathering, memoing and using theoretical sampling. Additionally, like SGT, ConGT starts with a literature review and research questions from a substantive area. This is in contrast to GGT where there is no need to know more about the substantive area nor to determine what research has already been carried out and there is no need for any research questions.

ConGT follows many of the same principles as GT, however, there are differences; these have been summarised by Charmaz (2006, p.178) as her constructivist approach to GT:

- The grounded theory research process is fluid, interactive and open-ended
- The research problem informs initial methodological choices for data collection
- Researchers are part of what they study, not separate from it
- Grounded theory analysis shapes the conceptual content and direction of the study, the emerging analysis may lead to adopting multiple methods of data collection and to pursuing inquiry in several sites
- Successive levels of abstraction through comparative analysis constitute the core of grounded theory analysis

- Analytic directions arise from how the researcher interacts with and interpret their comparisons and emerging analyses rather than from external prescriptions.

4.4.6 *The Main Differences between the Approaches (Emerged, Forced and Constructed)*

There is current literature on GT methodologies and approaches. All provide information on the history of GT, the main divergent pathways and the many other approaches. This has made it very confusing for a novice researcher to clearly identify which approach to use.

Table 7: The three different approaches to GT

	Classic/Glaserian	**Straussian**	**Constructivist**
Identifying the problem area	Emergent No initial Literature Review	Previous experience Pragmatism Literature reviewed	Sensitising concepts Discipline- specific
Conduct of research and developing theory	Laissez-faire theory generation No verification necessary	Paradigm model theory. Verification (built-in to process)	Co-construction and reconstruction of data into theory
Relationship to participants	independent	active	Co-construction
Evaluating theory	Fit, work, relevance and modifiability	Validity, reliability, efficiency and sensitivity	Situating theory in time place, culture and context. Reflexive rendering of the researcher's position
Coding	Substantive Theoretical coding	Open coding Axial Coding Selective coding	Line-by-line conceptual coding Focused coding to synthesis large amounts of data. Open, focused and theoretical

Source: Adapted from Hunter et al. (2011)

Table 7 shows that there are some differences in terminology. For example theoretical sampling in the ConGT is the merging of concepts into groups, which takes place throughout the process. In GGT theoretical coding is part of the selective process which is used to integrate the grounded theory (Hernandez and Andrews 2012).

According to Ng and Hase (2008), Classic GTM was never intended for the researcher to enter the substantive field without knowledge of it. They say this is a misconception. Their interpretation does not however follow through with the process as outlined by Glaser and Strauss in their original guidelines to the approach.

Figure 6 shows pictorially how the Classic and Straussian approaches have fed into and help create the Constructivist approach. Charmaz brought relativity and subjectivity into the epistemological discourse on GTM (Charmaz 2014). Charmaz (2014) explains that social constructionist researchers viewed construction of the worlds they studied as accurate translations rather than as a construction and did not account for the processes involved. They ignored the subjectivity they brought to the process and failed to engage in reflexivity, this did not sit well with Charmaz. In the Constructivist approach to GTM, Charmaz acknowledges the researchers and participants involvement with the research process and hence the research, and is defined as, co-constructed: theory is reconstructed from the data. Basically, the data is broken in to component parts and then reconstructed in order for the theory to emerge (Hunter et al. 2010).

4.4.7 *Research Methodological Approach*

Having worked in a number of LSIs over the last fifteen years, the researcher had questions that were based on the success of the phenomenon being investigated.

Initially a prolonged literature search and review was carried out, and GTM was chosen as no clear theories had emerged from the literature that had been reviewed.

4.4.8 *Natural Sciences and the Social Sciences*

Qualitative research has had much criticism for not being rigorous or verifiable. Glaser says that verification belongs in quantitative research rather than qualitative research. The researcher is keenly aware of this issue as the audience for this research would mostly understand the philosophies based on quantitative research paradigms more common in the natural sciences. The researcher also comes from a natural science background, so validation is important for this research. GTM techniques and protocols, provide a demonstration of the analytical strengths that justify the process as being reproducible (Goulding 1998). Both SGT and ConGT have rigor and validation built in to the process. Both approaches were reviewed in detail before making a decision on the research approach.

Initially, the suitability of GTM was not clear to the researcher as GGT states that the researcher must not do a literature review nor start with a research question, and in addition the researcher should be naïve of the substantive research area. The researcher worked in the substantive area and the fact that research questions were identified, the literature searched and gaps were identified meant that the GGT approach was dismissed. It was the Straussian approach that appealed to the researcher initially. In particular the idea that prior knowledge of the substantive area was thought to be beneficial in identifying categories and for simply allowing the researcher to know when the saturation point had been met. In addition the structure of the processes and the focus on validity appealed to the researcher. This research has always been about the experiential journey, and on a more detailed review of the Constructivist approach to GTM the researcher has now realised that this approach is a better fit with the researcher's philosophical assumptions. SGT after refection appears to be overly complicated. This is mainly because of the additional coding stages required in SGT methodology. These include the addition of Open, axial and selective coding stages, making a total of 11 procedural stages. This makes the SGT methodology highly prescriptive and although the researcher found a structured methodology appealing, the overtly prescriptive nature of the methodology did not allow for the researcher to apply her own experiential learning from the sector to the theory building, which is a feature of ConGT. In addition SGT has a more deductive approach to the process, while in ConGT the concepts are constructed rather than discovered. Therefore in conclusion the researcher believes that knowledge is constructed from the data, from the participants and from the researcher's knowledge of the phenomenon.

4.5 Research Methods

The research methods that are used for this PhD project are directly related to the methodology chosen as the overarching process to be followed. For this research GTM has been chosen as a qualitative methodology (Table 5) and in-turn the ConGT approach will be employed.

The choice of research methods should be appropriate to the choice of methodology for GTM: the data collection instruments include tools that suit an interpretivist paradigm such as interviews, observation and document analysis (Table 5).

Grounded theory allows us to broaden and extend the social world of our participants.

> *"These methods provide a tool to enhance seeing but does not provide automatic insight" (Charmaz 2006, p.15)*

The tools themselves will not generate good analysis; you also need a keen eye, an open mind, a discerning ear and a steady hand to help you make sense of it all (Mitchell and Charmaz 1996). Charmaz (2006) says that methods are merely tools, so when combining them with insights, GT methods can help to make sense of the data that is generated.

4.5.1 *Comparative Analysis between Multiple Cases*

The Case Study methodology has become more widespread in GT research as it can be used in the development of theory. As discussed previously, the researcher had fully intended to follow the Case Study methodology, but it became apparent after a detailed review of the literature on Case Study methodology that there was a disconnect with certain elements of this methodology and the researcher's philosophical stance.

A number of researchers have used SGT together with Case Study Methodology and the researcher had access to this expertise in the University academic group. However, deciding to go with ConGT (as it fit the researcher's philosophical stance) was a big decision, as there was no experience in the academic group of this approach to GT. After researching ConGT the researcher was convinced that this approach to GT was the most appropriate. The issue, after this decision was made, was how she would continue to compare the Case LSIs? Comparing the Case LSI models was part of the research design and incorporating this comparative analysis within the research was a major part of the research study. Charmaz (2006) explains that comparisons are possible, between individuals, organisations and even nations.

In the case of this PhD study the participant organisations would be recruited and then placed strategically into the appropriate Case LSI model. This aspect of Case Study research was very appealing and using multiple cases in each Case LSI model would allow for replication of data. This is a major outcome of Case Study research (Gersick 1988). The careful recruitment of participants in order to compare and contrast variables is also very important. In addition, for multiple case studies the emerging theory can be replicated and compared (Yin 1994).

Yin (2003) discusses the two different approaches to case study methodologies, one where the researcher is involved in the case study and the other where the researcher is detached from the case being investigated. In this PhD research study the researcher has a detached approach to each of the Case LSIs, this is because no time was spent immersed in the case organisation other than the time spent doing the interviews.

These comparative cases are also viewed in the literature as multiple case studies. In these comparative cases (as they will be referred to in this research), the same questions are asked within each Case LSI model, so that differences can be identified. This will be done within each case comparator type and between the cases themselves. This research will compare each of the 5 Case LSI and look for where KEC is being done and which LSI has effective strategies in place. Each case comparator has similarities and differences; the differences are taken into account and will help answer the research questions. A few of the questions developed for each LSI has been customised to take into account their specific role and function.

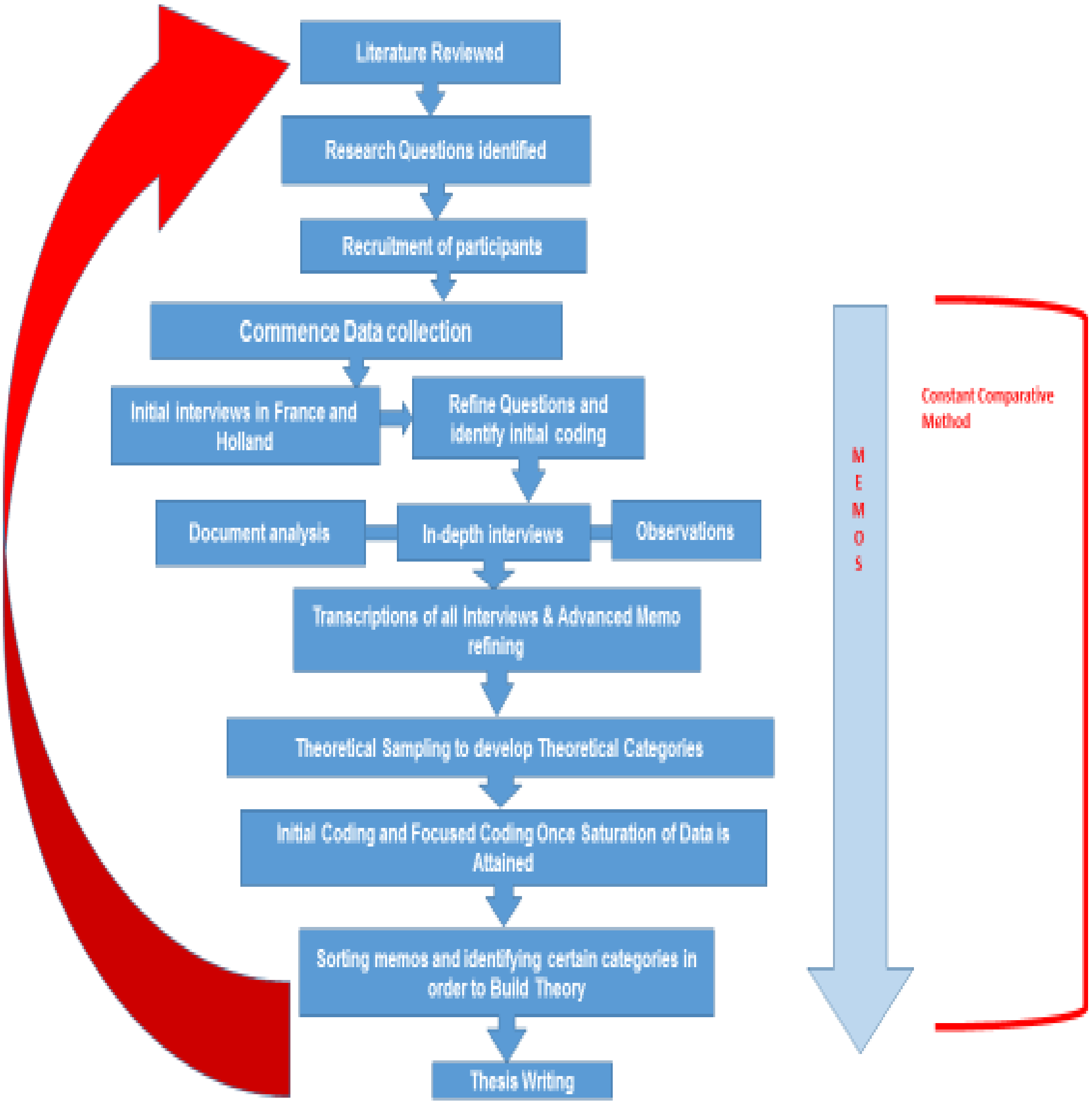
4.6 The Research Process

The diagram in Figure 7 represents the various stages of the process within ConGTM and shows the flow of the process in a sequential order. Some of these processes will take place within the next chapter and will be addressed further there.

The diagram represents the constant comparative methods starting from the beginning of the period of data collection and runs through the different stages right up to the thesis writing stage. Memo-writing follows the same pathway as the constant comparative methods. In other words, this activity takes place throughout the research process. The constant comparative process requires the use of memos and field notes. These allow the researcher to capture his or her own ideas and thoughts on what they are observing or hearing. Charmaz says these Memo-taking stages matter and will allow for more in-depth analysis (Charmaz 2014). Within Chapter 5, the results and analysis chapter, there are inserts of memos that are relevant to the discussion and then in Chapter 7, when the researcher has to link the data obtained from the entire research project to the literature that has been reviewed. Memo-taking is used here to collect ideas gained while undertaking this exercise, it is a lynch-pin tool of ConGTM and allows for a more robust and reliable project overall. This will be discussed in more detail later in this chapter.

One important stage was that of choosing the GTM approach that would be used to aid the analysis of the data. This started at the Transcriptions and Advanced Memo-writing stage and before the Initial and Focused Coding took place. This process required reading the literature on all the main approaches. A more in-depth discussion on these approaches are found earlier in this chapter. The choice has to reflect the researcher's raison d'etre in terms of philosophies, ontological and epistemological stance.

Figure 7: The Research Design Process



The different stages of the methodology process, incorporating the research methods, the memo-taking activity and the return to the literature. Progression is seen through the coding and the memos to finally build the theory and to finally write the thesis.
Adapted from Charmaz (2006, p.11, 2014, p.18)

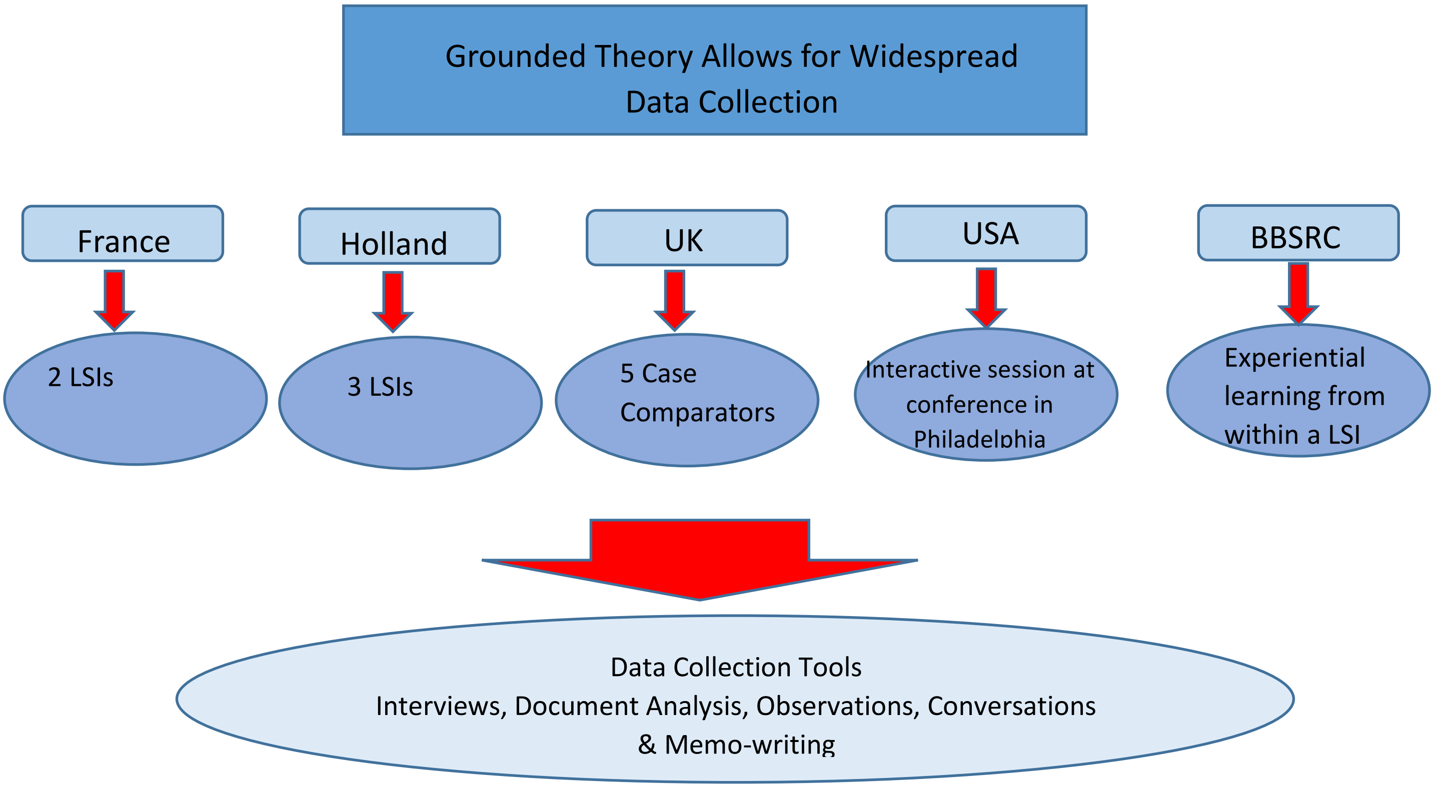
4.6.1 Research Design

The initial plan for this research would be to compare LSIs between different countries including France, Holland and USA to the UK. The researcher was able to gain some interviews from 2 different LSIs in Holland and France. However, it became clear that it was too difficult to gain access to more LSIs in these countries in terms of expense and time. It was therefore decided that the data that had been gathered would benefit the research to help justify assumptions and theoretical direction of the research, but could not be used as an equal comparator between these countries and the UK. As previously discussed under National Innovation Systems (NIS), both France and Holland have sufficiently similar NISs to allow for a comparison to benefit this research study.

Figure 8 provides an overview of the data collection locations and the tools used to collect this data. For France there were 2 and Holland 3 LSIs that were used in this PhD project. For the UK there are 5 Case LSI models which between then have 22 individual LSI organisations. The last two data collection areas are in the USA where primary data from a conference was added. This is discussed further in Chapter 5 under observational results. The last location is the BBSRC which is discussed in more details in the next section.

Figure 7 represents the design of the research. This has been customised for this PhD research study and is adapted from Charmarz (2006, 2014). The process charts the different stages that the research goes through. The researcher liked this flow diagram as it captured the continuous memo-taking activities that flow through-out the process that allows for the constant comparison of data. The large arrow clearly shows that there is a return to the literature at the writing up stage of the process, which is an important feature to capture here.

Figure 8: Data Collection Locations and Tools used



The different data collection sites and the tools used in the process
Source: This research

4.6.2 Research Data Collection Tools

This section will provide an overview of some of the tools that helped in this PhD project to collect data. A discussion on each of the tools is provided.

4.6.2.1 Interviews

The primary tool for data collection used in this research was in-depth semi structured interviews. Using interviews to collect primary data is used extensively in qualitative research and is very useful in understanding a person's experience and is therefore invaluable in an interpretative research paradigm.

> *"In an ideal world, 'good' researchers plan and conduct interview sessions such that 'good' interviewees feel compelled to share openly their considerable knowledge" (Alevesson, Ashcraft and Thomas 2008, p.257).*

Identifying high calibre interview participants is paramount. Careful recruitment of participants is important and needs to fit the epistemological stance and the substantive area for the research (Alevesson, Ashcraft and Thomas 2008). The researcher needed to be aware that recruitment of leaders such as CEOs and directors of LSIs (or those in power) can be a barrier to extracting experiences rather than *'public relations rhetoric'* (Charmaz 2006, p.27). These participants may view the researcher suspiciously and distrust the intentions of the research.

Interviews can range from highly structured, complete with detailed interview guides (so-called speaking questionnaires), to loosely structured or semi-structured interview questions. For this research, careful planning and thought was used to build the semi-structured list of questions. The interview questions would have appeared from the outside as structured neo-positivists, however the tactic was to present open-ended questions to the participants in order to help them understand the mode of questioning and to gain their confidence that the process would not be a critical interview of them or of their intermediaries function. The researcher was able to build on these opening questions with other questions that specifically related to the role and function of the intermediary case. Therefore the participant was happy to provide a more in-depth view by willingly answering the follow-on questions.

> *"By creating open-ended, non-judgemental questions, you encourage unanticipated statements and stories to emerge." (Charmaz 2006, p.26)*

The benefits of having a semi-structured list of questions is not just for the participant to see the line of questioning that will be asked during the interview, but to help the researcher to focus on what is being said and to have a list of follow-on questions waiting to be used when needed. These follow-on questions helped to confirm and clarify the emerging data, allowing the researcher to probe for specific experiences from each participant. As the process continues new ideas and understanding of the phenomenon will emerge.

The emergent nature of interviewing as a tool fits well into GTM. In-depth interviews also fit with the other modes of data generation like observation and document analysis. Charmaz (2006) discusses how interviews fit with GTM, she says:

> *"Interviewing is a flexible, emergent technique, ideas and issues emerge during the interview and the interviewers can immediately pursue these leads" (Charmaz 2006, p.29).*

She believes that the combination of control and flexibility that is characteristic with in-depth interviews are a good fit with GTM. The analytical processes involved in GTM prevent any preconceived ideas from entering the analysis. This is done through the different stages of coding and sampling of the data and allows for an…

> "*analytical incisiveness of the resultant analysis"* (Charmaz, 2006, p.29).

The interview was structured in three parts. The first part consisted of questions that helped to break the ice and to ease the participant into the interview. The second was a cluster of questions that were related to function and operations and the final batch of questions were centred around their thoughts and insights on the phenomenon under investigation. The researcher always ended by asking the participant if there was anything further they wanted to add and if not the digital recorder was switched off and the participants were assured that the details would be anonymised. They usually offered to help with any follow-up questions that the researcher may have post interview.

4.6.2.2 Document Analysis

In this research it was clear that data would not just be collected from a single source. The main tool for data collection was in-depth interviews as described above, however, throughout the research other methods were used, including observational data, (from events, meetings and conferences attended) and secondary data from written material pertaining to the research area. The data from the analysis of documents is used to verify and amplify evidence of data gathered from other sources (Yin 2003).

The researcher used a range of secondary data from a variety of sources including: websites, journals, and reports that were available on the different LSI case comparators; all of the information was available in the public domain. This is in line with Glaser's (1978) assumption that "*all is data*". This rich source of data was collected and includes the memos that were taken throughout the research process, which can then be triangulated with other data during the analysis phase of the research.

4.6.2.3 Observation

There are two ways that observations can be included within the research: non-participant and participant observation (Hussey and Hussey 1997). The researcher used non-participant observation to gather data. The idea was to observe in a covert way in order to capture behaviours and actions without influencing either. The researcher catalogued what was observed through memo-writing.

Observations made during the interview process were noted on memos. In addition the interviews were recorded with the participant's consent. At the transcription stage, memos were created after carefully listening to each recording, which allowed the researcher to position the conversation and thereby pick up any ideas or concepts not originally captured. This meant that important observations were transcribed into memos by the researcher. This in-turned allowed the researcher to capture important facts relevant to the research.

4.6.2.4 Field notes

All of the tools used for data collection used (interviews, document analysis and observation) required field notes or what within GTM is known as memo-writing. Memo-writing is a vital part of the GTM process. In GTM memo-writing will start when the research begins, and according to Birks and Mills (2011) is basically an audit trail. These memos are used to collect information on the actual research surrounding the research, capturing the thoughts and ideas that the researcher had during the process. In addition the researcher can make notes on their interpretation of what is being said or observed. They can also note any interesting environmental or political activity at the time the memo was made. It is also used later in determining coding. Memo-writing is also part of the data analysis in GTM and is discussed in more detail later in this chapter.

4.6.3 *Working with the Biotechnology and Biosciences Research Council (BBSRC)*

At the point where the data collection had just started the researcher was offered a secondment at the BBSRC to work on their innovation campus strategy that feeds into UK policy development. After discussions on the opportunity they offered, it seemed sensible to take up the offer as the work would be directly related to the research study area and the benefit and exposure that the role would afford seemed to present a great opportunity for this PhD research study. Instead of a secondment the researcher was given a one year part-time employment contract.

4.6.4 *The Outcome of Working with the BBSRC*

As the researcher was using a grounded theory methodology for the research, she was able to collect observable data (from visits and conferences) and documentary evidence that benefited the research. In addition, the BBSRC was very supportive of the interviews that had already been arranged and provided some excellent contacts for interviews with additional participants. The work the researcher carried out for the BBSRC included a review of its documents on research and innovation campuses across the UK. This was considered to be an exerciser in document analysis with the intention of providing a gap analysis.

The many events, conferences and workshops attended provided a great opportunity for observation and for memo-writing, ideas thoughts and suggestions that could benefit the theory development aspects of this research. The BBSRC itself is an LSI and although the researcher was unable to get any interviews from the BBSRC, she was able to observe and experience real life in an LSI. The whole experience provided access to rich data that has been invaluable to helping to answer the research questions and in developing novel theory. The support of an organisation such as the BBSRC was very encouraging for the researcher. A list of all the activities, which includes the events, workshops and conferences attended can be found in Table 8 below.

Table 8: Events and Meetings Supported by the BBSRC for the duration of 1 year.

Date	Activity	Outcome
February	• Attended Scottish Enterprise Life Science Awards Dinner (5.2.14) • Attended Auril meeting on intermediaries in Edinburgh (20.2.14)	Networking opportunity – Spoke to CEO from Cell Therapies Catapult (agreed to take part in study)
March	• Edinburgh BioQuarter Seminar with J&J (17.3.14) • Research seminars from Jason Whalleu and Core Values from the Wood Group (19.3.14) • Research and Innovation funding, commercialisation and infrastructure in the UK conference, Westminster, London (27.3.14)	Made contact with J&J regarding my research
May	• Presented a talk to the BBSRC on my research (7.5.14) • Attended the BioDundee Conference (20/21.5.14)	Attended by KEC team at BBSRC
June	• Meeting with business associate life sciences • Innovation Conference, Camden, London (10.6.14) • Harwell Campus visit (17.6.14)	Met Prof J. Howells and A. Weatherley Talk from catapult centre and tour of Diamond centre.

		Met key STFC people. introduction made to Gordon Duncan at Harwell (4.5.14)
July	• Meeting at Dept of Business Innovation and Skills (Victoria, London) (4.7.14) • BBSRC Shared Value workshop (8.7.14) • UKSPA conference Birmingham (10/11 July) • Glasgow event on life sciences (22.7.14)	Report on UK Life science Cluster Network Organisations Met CEO of UKSPA David Hardman
August	• Meeting with SE Julia Brown (4.8.14) • Kate Rowley - Nexxus (6.7.14) • Marilyn Robertson –Stem Cell Network (8.8.14) • Edinburgh BioQuarter – (20.8.14)	Interviewed for study Interviewed for study Interviewed for study
September	• BioDundee interview (11.9.14) • Meeting with SFC (12.9.14) • Head of Entrepreneurship at UoD Alastair McGill (15.8.14) • Rothamsted (22.9.14) • Cell Therapies Catapult (24.9.14)	Interviewed for study Interviewed for study Interviewed for study

	• Organised a talk at the BBSRC by the Sir Francis Crick Institute (25.9.14) • Queen Margaret University Innovation Hub visit (29.9.14)	Introduced Speaker Interviewed for study
October	• Meeting Deputy CEO of BBSRC Steve Visccher (1.10.14) • Attend BBSRC meeting in St Andrews University • Pentalnds Science Park (7.10.14) • BioCity (17.10.14) • BioDesign Workshop (18.10.14) • Dundee Technopole Incubator (23.10.14) • Glasgow University event on Scottish Innovation Centres (27.10.14) • Roslin BioCentre campus (28.10.14) • One Nucleus CNO 28.10.14)	Assigned project to look at how BBSRC can help the campuses with International activities. Invitation to visit their Innovation Hub Interviewed for study Interviewed for study Interviewed for study Interviewed for study Interviewed for study
November	• Innovate UK conference London (5.11.14)	Attended workshops on intermediaries.

	• Queen Mary Innovation Centre, London (7.11.14) • Senior member from SE (11.11.14) • Royal Society of Chemistry seminar (12.11.14) • University of Dundee Incubator (13.11.14) • BBSRC International Brainstorm event (14.11.14) • University of Dundee TTO (18.11.14) • University of Edinburgh TTO (27.11.14)	Interviewed for study Invited to James Hutton Innovation hub discussions Interviewed for study Interviewed for study Interviewed for study
December	• Entrepreneurship Manager UoD (3.12.14) • MBM on Entrepreneurship (3.12.14) • James Hutton Innovation Hub Meeting (8.12.14)	

The use of secondary data within this research has been extensive and together with the primary data, allows for the reconstruction of the data into theory at the analysis stage. Table 8 on the events and activities that took place during the 1 year employment with the BBSRC outlines all the events that were made available to the researcher, however, the BBSRC also made available many reports, journals and internal documents relevant to the substantive area of the study. Although the details of these reports could not be set out explicitly within this study due to confidentiality, the researcher was able to inform this study through document and content analysis, and through other secondary data translated into memos and field notes, which played an important function in the analysis and subsequent re-construction of data into theory.

The data was collected from individual interviews and then observations, document analysis and conversations were gathered from the time spent at the BBSRC. The conference in the USA was an interactive conference where a range of questions (see Chapter 5, (section 5.9.5)) were presented to the audience and then the data was captured. These questions related to a range of different LSIs. The conference is the largest gathering of life science delegates in the world, although the majority of the audience was from the USA. Unfortunately due to a technical fault outside the researcher's control, the data that was hoped for was not captured as originally envisioned. The researcher had to capture this data as observational data rather than primary data from the participants in the audience. The details of this attempt at collecting data has been included within this thesis as it would have been an innovative means of collecting this data. The questions were carefully crafted to generate results pertaining to answering the research questions and to help build new theory.

4.6.5 *Site and Participant Selection*

The next section will discuss the decision process for placing intermediaries into the 5 Case LSIs. Most of the participants already had a professional rapport with the researcher, which made the case selection process easier and some of the participants were recommendations via the BBSRC or other sources.

The sites chosen were based on the specific case which are all different by nature. A list was made of LSIs the researcher could access easily and which she might have known professionally or had been associated with her in the sector. Each LSI was bounded by a specific requisite: each had to be an organisation with a physical building whose main function was that of a "bridging organisation", they could be private or publicly funded or both, and they had to work specifically in the life sciences sector. These selection factors were developed after the researcher had reviewed the literature. It is important to identify the unit for selection prior at the data collection stage (Patton 1987). There had been a number of researchers working on different innovation intermediaries, however, none were specifically working in the life sciences sector and none were comparing different intermediaries within the LS sector.

Once most of the participant LSIs were recruited, the researcher then had to decide how they could be compared. On exploring the role and function of each of the individual LSIs the researcher was able to place into batches the 22 different LSIs. These batches evolved into the Case LSIs. The researcher had created 5 different Case LSI comparator models, and each of the 30 participants from the 22 different LSIs were placed in one of these Case LSI models. These boundary cases would allow for comparisons between them; an important feature of the study. The 5 different Case LSIs, the multiple case comparators, and each of the LSIs fit within one these 5 Cases LSI models. Tables 9 to 14 are the 5 different Case LSI models and these have been determined based on the role and function of each individual LSI. This differentiator places each LSI into the different case models.

The sample selection was carefully reviewed once the list of individual LSIs was determined. The researcher then made her selection based on the results she hoped to see from each Case LSI model and where they might help with answering the 4 RQs. A comparison between publicly funded and privately funded LSIs would, it was hoped, provide insights into how well each model operated against each other. Location was another factor that was considered espcially to be able to evaluate the importance of locating an LSI in close proximity to an anchor organisation. These variables would ensure a good comparison was made and was important to the choices made on recruitment of participant LSIs. A number of lists were made and reviewed before the process started.

Having worked in the LS sector for 15 years the researcher was able to place the individual LSIs in to the 5 different Case LSI models quite easily. In addition to this the researcher was able to gain a better understanding of the individual LSI from researching their organisation’s websites. Creating a bounded Case LSI model, helped to ensure that the study did not have too many LSIs recruited. On review, and in discussion with the supervisory group, it was clear that a good mix of LSIs had been recruited which would generate interesting and good comparative data. As previously discussed under the Triple Helix, every one of the 22 different LSIs who participated in this study were located at the intersection of the 3 sector helices in the ‘hybrid’ organisation space. See figure 5 the Triple Helix Model.

This next section provides an overview of the organisations where primary data was collected.

Table 9: A break-down of the case comparators

Case Comparator	Science Parks and Incubators	Technology Transfer Offices (TTOs)	Sector Specific Thematic Intermediaries	Cluster Network Organisations	Research Institutes
UK	6	3	4	3	1
France	0	0	0	1	1
Holland	1	1	1	0	0
Total	7	4	5	4	2

Table 9 above shows the numbers of organisations from which data was collected. The tables below are LSIs that participated in this research. They are sorted into one of the five different cases and put into the correct case comparator.

Table 10: Case 1: Science parks and incubators

Science Parks and Incubators
BioCity Nottingham
Stevenage Bioscience Catalyst
Dundee Technopole
Leiden Science Park, Holland
Pentlands Science Park
Queen Mary Innovation Centre, London
Roslin BioCentre

Table 11: Case 2: The Cluster network Organisations

Cluster Network Intermediary
One Nucleus
BioDundee
Lyon Biopole
Nexxus

Table 12: Case 3: Research Institutes and Innovation Centres

Research Institutes and Innovation Centres (RICs)
BioAster -France
Rothamsted Research (Agri)

Table 13: Case 4: Sector Specific thematic intermediaries

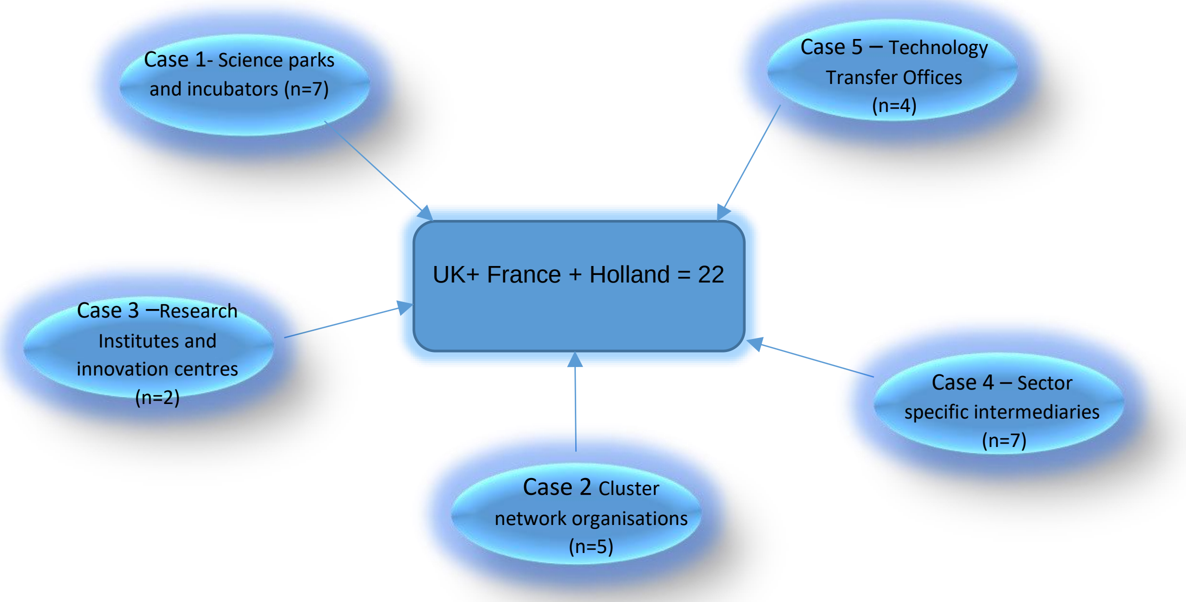
Sector Specific Thematic Intermediaries
Stem Cell Network
Medicine Initiative Leiden, Holland
Edinburgh BioQuarter-Medicine
Cell Therapies Catapult
Knowledge Transfer Network

Table 14: Case 5: Technology Transfer Offices (TTOs)

Technology Transfer Offices
University of Dundee
University of St Andrews
University of Edinburgh
University of Leiden

A total of 22 participating organisations (n=22) took part (see Figure 9, which provides a summary of the case organisations taking part). Besides Edinburgh BioQuarter who allowed for 4 individuals to be interviewed there was generally only 1 interviewee from each of the 22 participating LSIs. The number of interviews that were completed was 30. Originally 36 email letters requesting uptake to the study were sent out. The 61% participation rate achieved was encouraging, and there was concern that there would be too many wanting to take part. Some of those organisations who had signed up and later changed their minds stated that time and workload had been the issue for their withdrawal.

Figure 9: Summary of the Case LSIs organisations who took park



A visual for the total number of case organisations (22)
Source: This research

Each of the thirty-six participants were contacted initially by email to discuss the research aims and objectives. Once agreement to participate had been received a copy of the interview questions was sent to them as a guide to the questions that would be asked of them. They were also informed that they would have to sign two copies of a consent form (see Appendix 1 for a template that was signed by each participant) and that the interviews would be digitally recorded. Dates and times were arranged for face to face interviews at the premises of the participant. At the interviews the researcher went over the consent form with the participant and explained that the data obtained would be confidential and it would be anonymised, they were also informed that they could stop the interview at any time if they wished. A number of participants wanted to only do the interviews over the telephone, this was usually due to time issues.

The information provided helped to inform the participants at the invitation stage, this approach produced a healthy cohort of participants, all at the leadership level, and allowed them to feel that they could trust the researcher, which was an important part of the success of the recruitment process.

4.7 Data Analysis

4.7.1 *Grounded Theory Coding Procedures*

> *"Coding gives you tools for interrogating, sorting and synthesizing hundreds of pages of interviews, field notes, documents and other texts" (Charmaz 2014, p.113)*

Through coding you define what is going on with the data and then eventually the meaning will crystallise (Charmaz, 2014). Coding is pivotal between collecting data and generating new theory: put simply, the developing theory helps to explain the data.

Coding within ConGT consist of two main phases, these are: (1) initial coding, and (2) a focused selective coding (Charmaz 2006). The next section will explain these two main areas of coding used within ConGT.

4.7.2 *Initial Coding*

The initial coding involves a close scrutiny of the data, this involves naming each line, segment or word found in the data collected. This 'line by line' coding, as it is sometimes referred to, brings the researcher closer to the data. This initial stage of the coding process has an element of data mining, in that certain areas are identified to pursue for further analysis or new data to be collected.

This form of coding involved reviewing each of the interview transcripts, to identify possible codes. These codes take the form of gerunds or words ending in 'ing' or action words. This helped review the role of the case LSI that was interviewed.

This close scrutiny of each word on each line help to ensure that the data is derived from the participants and to eliminate any preconceived views that the researcher may have (Charmaz 2006)

4.7.3 *Focused Coding & Categorising*

The focused coding is a streamlining phase, where further investigation is made into data that has been identified as significant. This essentially means that the most frequently used initial codes are used. The ongoing constant comparative method allows for some of the early initial codes to be subsumed by more relevant focused codes.

Some of the initial codes once analysed can also become elevated to a category. A category is a theme or variable that allows us to make sense of what the data is saying. Categories help by clarifying ideas, actions or processes within the data. Charmaz (2011) describes categorizing as

> *"the analytical step in GT of selecting certain codes as having overriding significance"* (Charmaz 2011, p.341).

More will be discussed on this level of coding within the next chapter as many of the significant categories are likely to be the basis for the theories derived.

4.7.4 *Constant comparative Method*

Constant comparative method has been mentioned previously within this chapter. An understanding of the method may have already been gleaned from this previous information. It is however important to help present and define the fundamentals of the process involved and help the reader understand where this process will lead.

The constant comparative method is used from the onset of a research study, and the outcome is that it will enable the researcher to generate new theory. This is done by comparing data with data, code with code, category with category and category with a concept (Charmaz 2011). Using this method enables the focused coding part as well as the categorizing stage of the analysis process to all for theory to emerge,

This element of the process is important as the research will be comparing each of the case comparators with each other as the research forms a comparative analysis study. Comparing each case comparator in order to assess the value will be part of the analysis stage of this thesis.

4.7.5 *Memo-writing*

We previously discussed field notes which we call memos in GTM. They are however more than just notes; they are a way to capture our informal analytical thoughts and ideas as they are formed.

There is no prescription on how many memos there should be or even the format they are written in. These aspects of memo-writing are all determined by the researcher (Kenealy 2012). Kenealy suggests that researchers should write up field notes after each interview is completed. In this research, some notes were taken during the interview, but most were hand written post-interview and then incorporated as a comment during the transcription phase. Within the text these comments are highlighted and titled “memo”. The transcription of the interviews involved listening to the recording of the interview and then transcribing word for word. Listening to the interviews again, helped to bring to mind the thoughts and ideas the researcher had during the interview process. It also allowed the researcher to pick up any curios said or intonations or emphasis made at the time and write a memo. These memos will aid the analysis process and allow the researcher to understand the meaning of a statement, an intonation or even a word. Many of the codes and categories that are used within the process are derived from analysing these interview memos.

4.7.6 *Validity and Reliability*

With GTM the issue of validity and reliability is addressed by a number of techniques that are built-in to the methodology. One of the techniques is that of constant comparison of the data (as discussed earlier), this is where the researcher is constantly comparing and contrasting data that is emerging. This technique is believed to help towards removing any bias (Loonham 2014).

Another tool used for ensuring validity and reliability are the memos created throughout the research process. It is considered to be the most significant factor in ensuring quality in GT (Charmaz 2006). These memos help to reduce the researcher's bias and help in maintaining an audit trail by providing a record of events, and more importantly providing a record of the process for the reviewer.

It is important to demonstrate rigour throughout the research process, ensuring that the research will stand up to the scrutiny of reviewers is an important factor. The main reasons that GTM is attractive to many researchers is because it follows procedural precision and takes into account the researchers own experience and the methodological congruence (Birks and Mills 2015).

4.7.7 *Theoretical Sampling*

Theoretical sampling helps to guide where the researcher goes, whereas initial sampling helps determine cases, situations, and or settings before you enter the field (Charmaz 2011). In addition Charmaz (2011) says that one should not use theoretical sampling as in the traditional sense. Within qualitative research traditionally a:

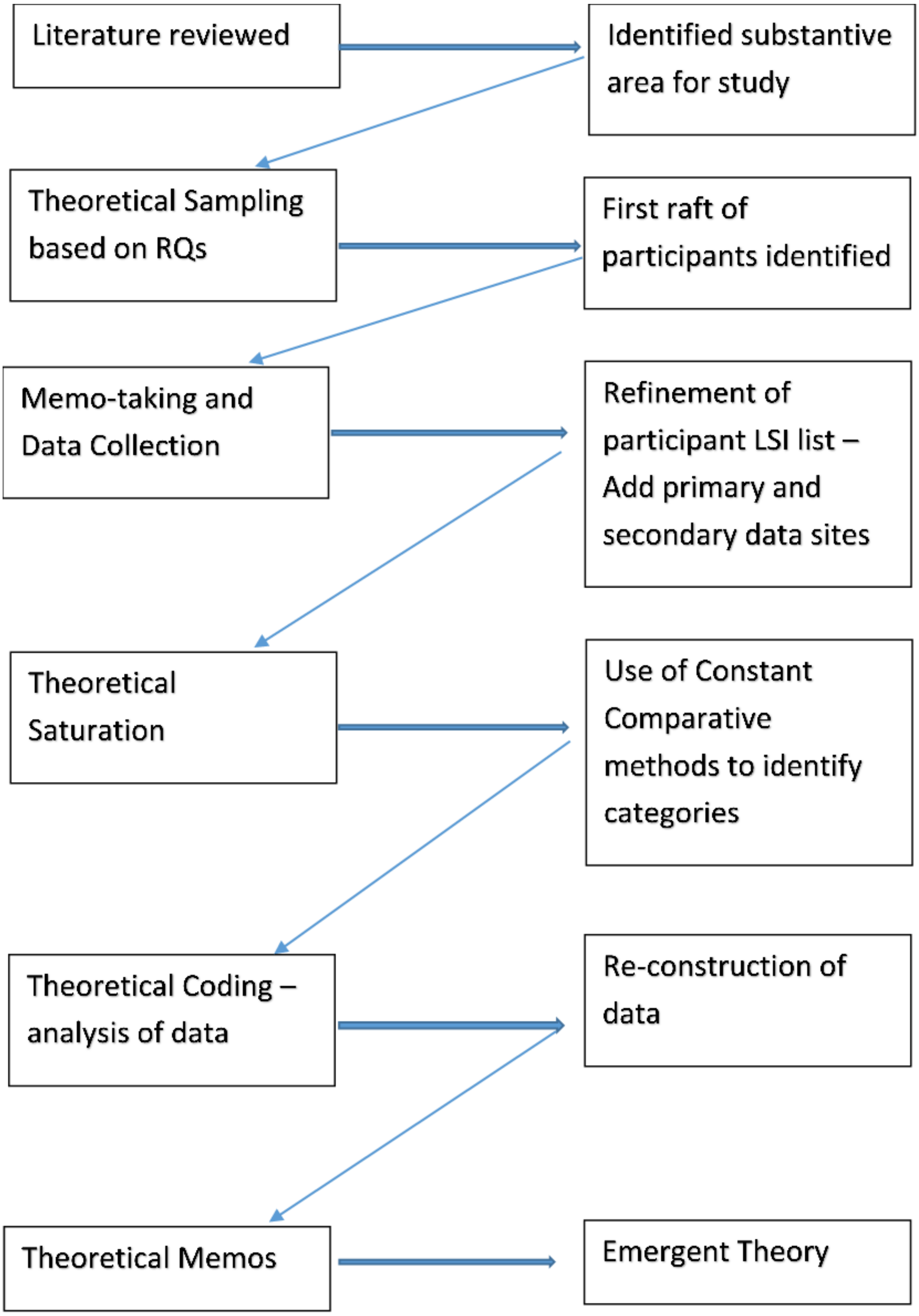
- Sample is used to address the initial research questions and
- Sampling is carried out until no new data emerges

In ConGTM the assumption is that theoretical sampling should allow for flexibility in the research process. This flexibility allows the researcher to change direction or add a participant, or even remove one. In addition observations from conferences, events and various meetings can also be used (Glaser 1978, Strauss and Corbin 1990). Memos made will include all the wider secondary data collected. Only when saturation is reached will the data collection cease.

Memo-writing aids the process of theoretical sampling. Theoretical sampling aids the collection of data that elaborates and refines the emerging grounded theory. It directs the researcher where to go based on the theoretical analysis. This is a pivotal strategy that helps to identify and develop the properties for your categories (Charmaz 2011).

Theoretical sampling also involves the use of abductive reasoning by the researcher. This is when the researcher identifies something strange or confusing and where the researcher then invokes their imagination in order to make the inferential leap to consider all possibilities for the observed data. This analytical stage will require a return to the data for further examination and at this point it may require the collection of further data.

Figure 10: The Theoretical Sampling Process



The theoretical process diagram shown in Figure 10 provides a visual of the process from the initial identification and selection of the participant LSIs from the literature, to the theoretical sampling - the more strategic identification of the LSIs for the study that will help to answer the RQs and for which a comparison between the Case LSI models can help generate relevant data.

Memo-taking, as previously described, is central to GTM and it is used extensively to interpret ideas and observations throughout the research process. Haslam (2002) describes Memos as the 'the building blocks'. Once saturation has been reached the use of constant comparative methods (which includes comparing data with data (including memos) will allow the categories to be identified. Once the categories have been identified, all the data is sorted. In the case of this study, post-it style notes were used as memos. This made it easier for theoretical sorting by identifying similarities, connections and concepts (Glaser 1978).

Through this theoretical coding and analysis the data is once again re-constructed then checked against the theoretical memos to identify the emergent theory.

4.8 Conclusion

This chapter begun with a journey to understand better which methodological approach, along with the researcher's philosophical assumptions, is linked to the research phenomenon itself. A qualitative study was decided upon and then based on ontological, epistemological and philosophical choices, a GTM was thought to be the best way forward, At the start of the research the researcher had assumed that the Strauss and Corbin approach would best suit the research study, however on further reading and exploration of the literature on GTM, the constructivist approach was found to better suit the researcher's philosophical beliefs.

After the decision and justification for these choices were made, the discussion moved on to research methods. The next section was the research design and process section, this covered information on the research participants and how they were selected for the study. The section also covered discussions on the choice of research tools like, interviews, observations and document analysis The final part of the chapter covered data analysis. Here the different stages of coding were discussed as well as some of the strategies employed within GTM like the constant comparative method and theoretical sampling.

Chapter 5 Results and Analysis

5.1 Introduction

This chapter discusses and analyses the results obtained from both interviews conducted and with senior managers from individual LSIs within the 5 Case model LSIs and observational data that has been analysed.

In addition a description of the approach taken to coding and an explanation of how under the initial coding eight main categories and sub-categories were identified. An example of the initial coding has been included as appendix 9 in this thesis.

Much of the discussion is centred on the five main categories that constitute the focused codes. Detailed analysis for each Case LSI model is outlined which includes interview data and memos presented within the analysis and discussion of the findings.

The chapter will end with the observational data which is reviewed and analysed in relation to the main categories of the focused codes.

It should be noted here that although the participants were happy for their LSIs to be included and disclosed in this PhD research study, their individual identities and those of any organisation that they may be have discussed as part of the interview have been redacted to protect these identities.

Finally please note that the results do not correspond to the list of individual participants within each Case LSI.

5.2 Approaches to Coding

Line by line Coding ⟶ Initial Coding ⟶ Focused Coding

5.2.1 *Coding procedure:*

Each of the transcripts have been scrutinised using the line by line method. This highlighted the important aspects from the interviews, and has revealed the initial codes that the researcher has used. Eight main categories have been developed and some have additional sub-categories, where the researcher deemed it necessary to sub-divide the main category (Charmaz 2014). As discussed in Chapter 3, ConGTM is very much a procedural method, although it does allow for flexibility. This is because the methodology is still in flux and new refined additions are made continually. Therefore there is some procedural elements to ConGT, what it is not is a set process or prescribed method (Goulding 2002).

5.2.2 *Deriving Initial Coding Results*

The categories identified came from a detailed analysis of the raw data. This involved careful line by line scrutiny. Charmaz (2014) suggests the use of 'gerunds' or words that end in 'ing' (doing words) when choosing your initial categories. This is not as easy as it sounds when having to apply it to data with a basis in business management rather than nursing, psychology or research where the participants are talking freely about a personal experience. The researcher did where possible try to incorporate this suggestion.

Another consideration was whether to use Axial Coding, which was recommended by Strauss and Corbin (1997), as they believe that this type of coding helps to relate the categories to the sub-categories, by asking how they are related. After some researching and considerations, it was decided that Axial Coding was not necessary in order to explain the relationship, the researcher felt that the relationship between the categories and the sub-categories were self-explanatory. In fact, below is what Charmaz says about this decision:

> *"Those who prefer simple, flexible guidelines – and can tolerate ambiguity – do not need to do axial coding. Instead they can follow the leads that they define in their empirical materials." (Charmaz, 2014, p.148)*

Table 15: Initial Coding

	Category	**Sub-category**
1	The life cycle of the project/funding	Coming to an end Just starting
2	Engaging stakeholders	Engaging with academic stakeholders Engaging with Industry stakeholders
3	The power of brands	
4	Being in a membership Organisation	
5	Measuring success	
6	The main barriers to success	
7	The Expectation Gap	Customers Funders Government Bodies
8	The KEC Activities	

Table 15 is divided into eight categories and the sub-categories that constitutes the initial coding.

Once the categories and sub-categories were identified the researcher proceeded with comparing data with data for each of the Case LSIs of which there are five different Case LSI models.

5.2.3 *Deriving Focused and Theoretical Codes*

Moving forward in the analytical process from the initial codes and the sub-categories, which were more descriptive in nature, to the next stage of the ConGT method is to identify the more 'focused' codes. These codes are derived from a more analytical perspective; the researcher is removed from the close scrutiny of the line by line data (Charmaz 2014). The focused codes can be more conceptual in nature and not resemble the codes that have gone before. According to Charmaz (2014) you gain greater theoretical sensitivity as you delve deeper asking more pertinent questions of the initial codes.

The focused coding analysis follows the suggested criteria by Charmaz (2014) in identifying these codes.

- *What do you find when you compare your initial codes with data?*
- *In which ways might your initial codes reveal patterns?*
- *Which of these codes best account for the data?*
- *Have you raised theses codes to focused codes?*
- *What do your comparisons between codes indicate?*
- *Do your focused codes reveal gaps in the data?*

(Charmaz 2014, p.140)

Table 16: Focused Codes

Focused Codes
Bridging the divide between academia and industry
Recognising the power behind the brand
Understanding the factors for success
Understanding the expectations of stakeholders
Assessing how realistic commercialisation targets are

Table 16 is the list of the five focused codes that have been used throughout this PhD study. Some of these codes are derived from an amalgamation of more than one initial code or have been inspired by the initial codes.

5.3 Results, Analysis and Discussion from Case 1 LSIs

5.3.1 *Case 1: Science Parks and Incubators*

These include the following:

- Stevenage Bioscience Catalyst is an incubator that is based on the grounds of the Pharmaceutical Company GSK and was initially funded by the Wellcome Trust, GSK and East of England Development Agency (EEDA).
- Roslin BioCentre is an incubator that was created with the help of Scottish Enterprise, the University of Edinburgh and the BBSRC. The BBSRC and the University have commissioned a new incubator to be built that will be positioned near to the Research Institute. The new incubator will open in 2017.
- Queen Mary Innovation Centre is a level 3 bio-incubator with tenants within who are at the level 3 stage of incubation which means they have more than 5 employees, already have had £1-2 million worth of investment, have solid IP and are now ready to move into science parks.
- Pentlands Science Park is a life sciences park based in Edinburgh. Moredun research institute, a world-class animal health research institute, is based in the centre of the activities on the park.
- Leiden Science Park is a biotechnology science park and has been in operation for more than 30 years. The city of Leiden is a fifteen minute train ride outside of Amsterdam.
- Dundee Technopole is the incubator for the University of Dundee with a main focus on life sciences.
- BioCity, a self-funded life science/biotechnology incubator that has separate sites in Nottingham, Scotland and Chester

5.3.2 *Introduction*

The analysis of the data demonstrated that the Case 1 LSIs have a range of different abilities when it comes to their function and role as knowledge brokers and facilitators of KEC. All of the LSIs in this model, house a range of LS companies of varying size.

5.3.3 *Bridging the divide between industry and academia*

The incubators have very young fledgling companies with only 1 or 2 employees when they first move in. Many had been incubated within universities first before going into the incubators.

> *1d: It is absolutely positive we are linked to the TTO and so we get access to what's coming through from the academic community.*

1d has a more traditional incubator model which is focused on spin-outs coming from the university that the incubator is attached to; the university here is the anchor. In the case of 1a the incubator is not linked to a specific university and this does have a downside to it, as the incubator management is not always aware of potentially new spin-outs.

> *1a: We tend to interact with a whole raft at different levels, so from the Tech Transfer Office, so we don't always see what's coming out*

1a does however believe that more engagement with the universities will not just help them to fill their incubator, it will also help the young company to develop and grow and in so doing the university would be on track for achieving its commercialisation goals.

> *1a: Whatever opportunity comes into 1a we could pick it up and develop it, so that's quite valuable for the TTO to be able to tap into. Which helps them get their job done. Then we have the academic groups, these are the ones who are working with companies.*

MEMO – They feel they could work with the university to benefit the spin-outs and the universities agenda in commercialisation

At the time of interview the researcher noted the different models of incubation from the different incubators visited. 1b is positioned very close to a global pharmaceutical company and have been marketing their incubator to the academic community across the UK as somewhere to come and develop innovations, with close proximity to a pharma company there could be more collaboration and funding for technology that the pharma company believe worthy of investment

MEMO- Universities are taking space in 1b because they see the benefit of incubating near to a big pharma company.

Some of the incubators especially 1a believe that there is no need to have a university as an anchor for the cluster, although they concede that the local university produces high quality graduates for the companies in their incubator.

> *1b: if you look at the portfolio that we've got, there isn't anything like the portfolio that we've already created in 18 months which includes having 2 universities ... so we have [redacted] in and they have the labs opposite they have 2 projects one in MS and the other in pain therapies'. [redacted] are going to take 3 labs on the top floor and they are doing spin-outs so very different models for different universities, [redacted] are doing pre-company projects and we love that, because the University takes the lease and then they will take in and take out projects as they see fit to accelerate.*

Then 1c says they chose to have a pharma company as their anchor rather than a university or research institute.

> *1c: The bridging is very short. The bridge between the pharma company and the SME is deliberately short.*

MEMO- It takes a company who does not mind 'interference' from [redacted] to happily locate there.

5.3.4 *Recognising the power behind the brand*

This focus code also appeared as an initial code in its own right, although other initial codes also impact on this focused code too, including: Being in a membership organisation, measuring success and engaging stakeholders.

Nearly all the incubators and science parks interviewed have either their own brand that they can capitalise on or have anchor organisation located near to them. They all have a strategy that uses brand spill overs. 1b is located on the grounds of big pharma and definitely uses the big pharma brand to attract new tenants. Their tenants have not just been SMEs but universities who want to utilise the incubator and accelerator facilities there. Collaboration with the big pharma company is also important and the technological infrastructure of the Pharma Company can help progress products along the developmental pipeline.

Memo-They use the labs based within the incubator as a testing ground for commercialisation.

Likewise 1h can use the world famous [redacted] brand, made famous from the creation of [redacted] and is synonymous with the [redacted] brand. The interviewee from 1h explained that the brand had been discussed by the funders recently and the thinking was that it should change. He explained that it seemed to make no sense to him to throw away such a valuable brand and fought to keep it.

1f is a well-established science park that has the world renowned [redacted] Research Institute on site. The [redacted] brand brings in tenants who want to work with researchers in the animal research field to locate within the science park.

1d and 1g utilise the universities they are associated with. 1d in particular houses most of the university spin-outs from the life sciences because it can accommodate labs that small spin-outs from the university need.

> *1d: It's absolutely positive we are linked to the TTO and so we get access to what's coming through from the academic community.*

Using the brand to benefit the aims of the incubator can be used to the advantage of the incubator, but not using the university brand can also help the incubator to achieve its business objectives. They have the ability to choose how they want to be associated with the university.

> *1d: Because we're not the same as a TTO to internals and externals that's lost so we can take on a different persona as required and which can build relationship, neutrality, separate identity the flexibility we can offer as an intermediary, the relationships*

5.3.5 *Understanding the factors for success*

This focused code is a combination of the initial codes about the life cycle of the LSI and the LSIs engagement with a range of stakeholders.

1h in particular will be moving out of their current premises by 2018 and the companies located within this incubator will be expected to re-locate to new sites. This means that this incubator is in the process of winding down. One of the other incubators 1b which had only been in operation for 18 months at the time of the interview and 1g which was built at the onset of the recession in 2008 has been operational for six years at the time of the interview. They had their initial funding from their various stakeholders however, because of specific strategies' for attracting new tenants they have been successful at leveraging their funding.

1d, 1e and 1f have been around for a longer period. 1e was set up at the start of the Biotechnology revolution and has continued to grow. It is considered one of the more successful LS focused sciences parks in Europe. They are not just anchored to the University Medical School and Hospital, but have big pharma within their science park too. This LSI has been in operation over 30 years now and continues to attract companies of all sizes to locate there.

Most of the older LSIs when they were created would have been located near to a University or a hospital. The idea was that a cluster of companies would eventually spring up to tap into these research rich organisations. This has been the case for some of the Case1 LSIs. As discussed previously 1d, 1e, 1f, 1g and 1h are located with a university, a research institute, a hospital or a combination as their anchor. The question that has to be considered here is how successful has this strategy been for attracting and keeping companies within a cluster. 1a was established without an anchor as its focal point and 1b has a global pharmaceutical company as its anchor. 1a is clear that having an anchor is not necessary.

> *1a: Universities are useful and they are sources of skilled people , so we don't need to be on the campus having a university nearby as they're churning out skilled experience people, in [redacted] we have the university that produces graduates, post-graduates and those who have started companies. So I think that they're a limited source of new business opportunities and people aren't that bothered by interacting with universities………… Universities usually have an internal perspective, focused on significant research that's going on ……..*
>
> *1a: There are academics who are outward facing and who are doing things. One of the main issues with academics is that they are not responsive. People think it's something else but it often takes 2 months to get a response to a question via email and they never return a phone call, which makes it difficult for collaborations, the ones that are responsive we have good relationships with .*

1h also believes that the new focus on locating near to the research base will not be as successful as expected. 1h believes that the tenants don't necessarily work with the researchers and that despite being located nearby they have limited engagement.

> *Researcher: The Innovation centre will be located next to the research institute.*
>
> *1h: That's exactly it the idea there is that it should have a commercial and academic approach, in my opinion the link with the commercial side is not going to work as when the commercial organisation sets up they are not going to look backwards,*
>
> *1h: The only thing is that SMEs tend to keep to themselves and it's a bit of a challenge to get them to engage.*

> *MEMO-(Expectation Gap at work – if the idea is to have business entities working alongside academia, [redacted] predicts that won't happen)*

1b/c's approach to their anchor is clearly beneficial to SMEs, they have really considered the needs of the tenants and what resources can help to grow these companies.

> *1c: whole idea was to have a pharmaceutical company as an anchor tenant rather than a university because the senior people here know that Biotech companies don't really know much about development and regulatory needs, that's not their forte, they are so busy driving their technology early on and what we have here are people who live and breathe that stuff and can act as non-execs or in a non-exec type function and give advice to people and they can help bounce ideas and put some specifications on the outputs. The last thing we want is for all these companies to be dependent on [redacted], that's definitely not what we want.*
>
> *1b: We do business support we do incubation. Incubation is not about physical infrastructure it's all about mentoring, coaching, developing and either sign posting to funding or providing funding and incubators across the UK vary. Some have their own funds and some don't.*

1a has a similar approach, but they do it without an anchor organisation. They are very focussed on providing the ingredients to help the fledgling company grow. Many of the tenants are spin-outs or start-ups whose founders are usually PhD scientists without the knowhow and skills to build and grow companies. 1a provides management training, skills development, procurement and in finding suitable investors for the SMEs.

> *1a: we provide the facilities and service that they need, so what we have is very efficient.*

This next section was written as a result of interviewing the LSI that was built and grown during the recent recession in 2008.

The following memo was written at the time of the transcribing phase:

> *MEMO- If there's a will there's a way! This incubator was built during the financial crash of 2008. The university has invested solely in this endeavour.*

> *1g: A huge contribution by 1 small university to build companies and grow jobs. By far the largest in [redacted]. I came in 2009 and this building was built in the 2008 crash. The VCs have vanished. This is all financed through the Uni.*

The researcher interpreted this statement to mean if we have the right champions then we can make a success of our LSI despite the economic environment we have to work in. Having thought about what the ingredients to success means for all the LSIs this has been the biggest revelation. Individuals with energy and passion who craft and make their LSI a success virtually by a force of will, has to be one of the most important ingredients for success.

5.3.6 Understanding the Expectations of Stakeholders

The initial code of The Expectation Gap was divided into the three main stakeholders, customers, funders and government bodies. For some of these Case 1 LSIs the funders and government bodies were the same. For instance the funders maybe a government department like Innovate UK (formerly the Technology Strategy Board (TSB).

Each stakeholder has a different expectation from the LSI, for example the tenants in the incubators and science parks are attracted to a location not only because of the anchor tenant there, but also because of any potential customers, the facilities and services provided to them.

> *1f: Aside from that we try to keep the park full and ensure that people pay their rent and also that there are support services on site, things like security, catering, waste disposal and IT support all these things. So all these services are provided for the [redacted] group and for the tenants and some of the tenants can opt in to buy services but some services are mandatory others are paid for on a user basis, what this does is free up the tenants from having to worry about these types of services so they can focus on their core work.*

From the above insert from the interview transcript from 1h a whole range of services and facilities are provided and even these can be flexible for each specific tenant.

At one incubator it was clear that some of the potential tenants, specifically those looking to make the transition from being incubated within universities and research institutes, balk at the cost of making the transition.

> *1f: Sometimes but the challenge that we have with start-up and spin outs have been initially set up by the university and then been allowed to incubate in university labs and when you quote the price to them they run a mile because they're just not used to it.*

This early incubation space is highly competitive and another LSI was explaining that sometimes aggressive marketing can mean that a tenant is housed despite the LSI not being suitable.

> *1h: The councils are more concerned with the infrastructure and that we retain the tenant base here and I think we do that. [redacted] frankly have no interest in us what so ever and that's because their interest is geared to their own facilities, it doesn't hurt us as such but..*

> *1f: Things are quiet now. Everything is going to [redacted] and not to us. A company was a veterinary company and didn't come here! So that's annoying as we're trying to raise our profile and it's like they are working against us.*

MEMO- The incubator at [redacted] was built by [redacted] and they are aggressively marketing it and filling the incubator. Currently building a second one as the first one is full

1f was clearly upset about losing a suitable tenant that would fit very well into their LSI and would benefit from the research going on in the Institute there. What they find interesting is that the competitor was an original funder of the 1f LSI.

This insert was taken from a question asked about the barriers to success within the initial coding. This initial code helps us to understand the focused code of 'Understanding the Expectations of Stakeholders'.

> *1f: Money, [redacted] are a hindrance they can be a derisive org. But saying that we had lots of support in the early days. So [redacted] really isn't as good as it could be. We do Ok with the [redacted] Government they continue to value our input.*

The expectations from the perspective of the funders varies with each LSI within the Case 1 LSIs investigated. The funders from 1d are not doing it for the money; it's more about the growth of companies and the economic value of the region.

> *1d: We don't do it for the money, but there is definitely income generation. The economic benefit is important, creating jobs and often the funders ……………………..*

Whereas 1h's funders are about ticking a box and about reputation objectives. Both funders of 1d and 1h want to see the LSI fully occupied but they have additional expectations from the LSI they fund.

> *1h: Our other stakeholders are the [redacted] and the [redacted] are much more about reputational interested. For the [redacted] we're a few steps removed from the academic research they're much less concerned with that and more with the tech transfer aspect of it. For the Foundation their main concern is to realise value to the investment that they've put in over the years and also with their charity aims in the sector which again I think we tick that box.*

The funders from 1a and 1b have a different expectation from their LSI.

Researcher: So you do have plans to evolve the site, will you have a science park too?

1a: No we see companies growing there. What we found is that companies that like the environment for example we have companies with 12/130 employees and they started out with 3 on our site, so we want to stay one step ahead and build that will enable them to stay with us, we will evolve in to keeping companies for longer, but our focus is on the next generation of businesses coming through. Some will fail and some fall by the way-side and then a proportion of them will grow. In [redacted] that site will have 1000 people working on it and it was 450 people from [redacted] working on it. So as [redacted] was concerned that closure was a disaster and actually it's one of the best things that could happen to it

When 1b was asked about performance measures, it was clear that this included the normally seen metrics that show investments into the tenant companies and employee numbers within them. However, there was some indication from the responses that careful triaging of tenants takes place, which is demonstrated in the response about filling the building with quality tenants. Therefore we can deduce that choosing the tenants for the site is linked to the funder's expectations. In the case of 1b one of the funders is a pharmaceutical company who will invest in SMEs with a high potential in the therapeutic areas linked to their own R&D interests.

1b: That's a good question. So most incubators across the UK, including ourselves have some element of public funds, so we have some metrics around job creation and sales by tenant companies or in this space into investment into companies. So there are already 20 million £ in Venture capital investment in this building today. There's 2/3 million of Catalyst funding and there's already 100 people within these site passes in this building today. The building will only hold 200 people.

1b: I want more options at an early stage but I don't want it to become an excuse for the flood gates to open there should always be that quality. I would get fired here if I fill the building with things that are considered to be not of quality and that they have a chance, and it's only a chance as only 1 or 2/10 will make it all the way to the end game, so you just have to give yourself a better chance.

Expectation from the government bodies for many of the LSIs is tied into the funding. As 1b has said above

> *1b: That's a good question. So most incubators across the UK, including ourselves have some element of public funds……*

This public funding normally comes directly from central Government or via one of the Government departments like Innovate UK.

5.3.7 *Assessing how realistic commercialisation targets are*

In Chapter 3, we discussed the importance of knowledge exchange in the commercialisation process and the different types of knowledge exchange, Codified KE and Tacit KE. The funders of many LSIs believe that locating an incubator close to the research organisation like a university will enable this exchange to happen. The reality is probably something quite different. What we need to understand is that the culture within tenant companies are governed by business needs and not public sector organisation culture or needs which have different drivers. The funders may include the private sector, however, generally they consist of public sector organisations. For the most part the LSI manager usually has to manage these commercialisation expectations from its funders and governing bodies.

> *1g: The idea of exchange of ideas around the water cooler is not true, our people here are highly secretive. So Late stage incubators are all about business processes, business continuity and usually infrastructure focus. Their clinical wastes needs to be stored or are their equipment being maintained.*

As 1g suggested in the exert above, the tenants of late stage incubators have a different set of requirements, for instance their products and services may be more developed than for those companies in the early stage incubators like in 1d. 1a has a range of young start-ups and spin-out companies as well as the older more established company of 3 years and older. This mix will be helped by inspiring younger companies to emulate the older more established tenants.

The KEC element can be broken down into two parts, the KE and C. Most of the LSIs in Case1 engage in KE activities, putting on events throughout the year to help educate and allow discussion to flourish and therefore facilitating tacit KE.

> *1b: yes we do a lot of that, there are three to four major events that we do in a year .. so we have an Open Innovation summit, we had a summit on medical technologies and Sir William Castells chaired it and brought a panel of the good and the great. They talked about what convergence is all about and what the future looks like and that's the kind of quality thing we want to do. Then our marketing manager is doing all the 'how too' events, which is something that every incubator does, supplemented by information around funding, portals so there's also lots of things going on.*

> *1a: Yes that's really important it's part of the plan. We bring everyone together and we bring people in from outside. It's about quality not bums on seats.*

From the commercialisation side many of the LSIs interviewed have put in place specific focussed people who deal with the commercialisation aspects.

> *1a: We get very involved in the commercialisation process, we help find funding and people. I would rather have 1 good company rather than 10*

> *1f: looking at ways to develop that field and to generate new revenue streams from that. So aside from the research institute the [redacted] has 2 commercial subsidies –[redacted] which is a commercial company….*

> *1f: So they've created a business enterprise team to exploit the work going forward and to do that we want to create a commercialising hub so we want people to come in and interact. So there will be an interface.*

Commercialisation has a different meaning to different LSIs and it will be interesting to see how this part of KEC is achieved by each of the Case LSIs when we come to comparing them all later in chapter 6. The next section will look at applying the Focussed Codes to Case 2 LSIs.

5.4 Results, Analysis and Discussion from Case 2 LSIs

5.4.1 *Case 2: Life Science Specific Cluster Network Organisations*

These include the following:

- One Nucleus covers the SE of England and was created in 2010 by the merging of the London Biotechnology Network and the Eastern Region Biotechnology Initiative (ERBI), centred in Cambridge. One Nucleus is a membership organisation, whereby members have to pay a fee depending on the size of their organisation to join.

- Nexxus is a cluster network organisation that has now closed. It started in Glasgow and was based within the University of Glasgow. They had funding from Scottish Enterprise, European Regional Development Funds and the local council. They eventually expanded to include Edinburgh and were talking to BioDundee to join forces with them in order to cover the East Coast of Scotland.

- LyonBiopole is a cluster networking organisation that straddles the region of Rhone-Alpes and encompasses the cities of Lyon and Grenoble. Their network like BioDundee is also referred to as an umbrella organisation and have 17 institutes and 168 life sciences SMEs. Within LyonBiopole there are four biopharmaceutical companies that contribute towards the funding. However, the main source of funding is from the regional and National Government.

- BioDundee covers the Dundee region within Scotland and was the second UK cluster networking organisation to be created after ERBI. This organisation is free to join and has been funded by the European Regional Development Fund and Dundee City Council. They receive nominal amounts of funds from some of the members including the universities and institutes.

5.4.2 *Introduction*

Case 2: Cluster Network Organisations.

LSIs 2a and 2b have been around for more than 17 years, although 2a underwent a metamorphism in 2006 when it merged with the London Biotechnology Network to create a new branded entity.

2d is based in the Southern region of France and was only created in 2006, this LSI has been included here to help explore the Cluster Network Organisation model of LSIs within a different national innovation system (NIS) (but not dissimilar), although the main focus in this thesis is on the UK innovation systems.

The Case 2 LSIs have different business models and different streams of funding. 2a is a membership funded organisation that before undergoing its metamorphosis was funded by the Regional Development Agency and European Regional Development Fund. 2b, 2d and 2e all receive public sector funding. 2d has in addition 4 different private sector companies who contribute funding to this LSI, although, the bulk of the funding comes from Central Government. These differences have a dramatic effect on the services and operational models of each of these LSIs.

5.4.3 *Bridging the divide between industry and academia*

When it comes to the life cycle of these LSIs they have all changed. The brand for 2b has remained a constant over the years, however, changing political and economic impact has forced the 2b LSI to evolve.

> *2b: We never stand still, it changes from year to year adapting to what the needs are, which is why we're looking at widening out into the healthcare and beyond biotechnology…*

> *2b: That has changed slightly because in the area because we used to work much more closely with [redacted] as they had a local focus, there was a lot more Bus Dev activity in terms like working with companies and that doesn't happen anymore . The companies we work with are the ones we've met through the networking and have identified through networking. We are careful not to step on the toes of the account managers within [redacted], so there's no point us getting in the middle of that.*

2b LSI had previously been funded by the local economic development agency, this is no longer the case. They invite all stakeholders to attend their steering group, including [redacted], however are unsure why they attend.

2b: We need to make sure they know what's going on locally, like they attend the steering group, but we're not clear what for.

MEMO- engagement with industry appears to be non-existent now. It has very little involvement with companies, except through training and skills and networking opportunities.

2b have little direct engagement with the companies except through KE events.

Since losing their local economic development funding they have partnered with the University to apply jointly for ERDF.

2b: We've tried to work with the academic agents and do it in a way that they're happy with, so for eg with the University of [redacted] it is [redacted] and they can act like gatekeepers, well that's their role and that's fine, they're the ones who give us funding so we have to work around that.

LSI 2b had originally started out working with all the universities under its umbrella and had over the years developed a very good rapport with not just the business community but also the academic community. However as the life cycle of the LSI has progressed so too has their ability to operate like they originally had.

2b: One of the things that helped [redacted] to move forward was that we had identified that we had these kind of superstar scientist, who were willing to back the idea of this life science community to just beyond the walls of the university.

LSI 2e's lifecycle ground to a halt in 2013 nearly a year before the interview was carried out. 2e and 2b business models were very similar in that they were both there to serve both the academic and business communities equally for 2a this was also the case up until 2010 when they took on their current business model. For the French LSI they have just turned 10 years and have many achievements under their belt. Their funding covers a range of business development staff as well as marketing executives all focused on the goal of growing their cluster. They have 4 large biopharmaceutical companies located within their cluster who are fully engaged with the LSI. The aims and objectives started out the same for all of these LSIs, with each evolving in a different way and one closing its doors.

LSI 2e just like 2b had a good rapport with the academic community. They appealed to academics who wanted to get involved in more entrepreneurial things, but who normally couldn't afford to attend.

> *2e: We had an excellent relationship with the academic community, mostly because everything we did was free to attend and it's incredibly difficult for academics to find the money unless it comes out their own pocket to attend something.*

> *2e: The typical spilt of people attending events was around 50:50 and we had a high profile amongst academics at that time*

In addition to appealing to the academic community 2e also found a niche with the smaller SMEs who were not account managed by the local economic development agency. Although these small SMEs were not account managed by the local economic development agency they did help to market these companies. The LSI often wrote the case studies used to market the SME, as they got to know these companies.

> *2e: I would say especially for the business side that we were more focused on the SME than the large industry and this is more because of the types of things we used to do. For small companies important information on things like access to Clinical Trials, IP and funding mechanisms.*

> *2e: [redacted] offices would be working with. They would be working with kind of driving at the top highegians working with large pharma, large corporations. That said a lot of the PR and marketing that they used to do was for smaller companies and individuals.*

> *MEMO- [redacted] are looking to work with more established firms, which leaves a gap for the less established firms to get support from [redacted]*

5.4.4 *Recognising the Power behind the Brand*

Linked to the life cycle of these Case 2 LSIs is the changing brand for some the more mature LSIs.

We have discussed a little that 2a changed its name and rebranded itself in 2010.

> *2a: The name change has been fundamental to the company. We gave the sector 2 months' notice before merging the brands of* [redacted] *and* [redacted]*. We wanted to get it known that we were changing the brand and refocusing. We had 2 board members who didn't agree one from each network. 57% of our members thought it was time for a name change.*

This re-branding has been significant as the business model for 2a has also changed. It is now completely self-funded by re-creating itself as a membership organisation. They have a large number of companies who can join at different levels (bronze, silver and gold), this is linked to employee numbers.

2b has had their brand for over 17 years although they no longer provide the same services for the LS community, which appears to be due to dramatic changes to their funding over the years. 2b is hosted by the City Council and they have managed to continue to justify the continued investment in 1 full time employee (FTE) for a business development officer to co-ordinate the LSI.

> *2b: The brand is internationally recognised. People have heard of it. So we haven't tinkered with it we haven't ermm it's still our brand and ask if it's still relevant to the sector we ask ... because it is* [redacted] *and because it geographically places us, that's why we invest in it. Local initiatives are really important, because that's where you get buy-in from politicians from the local community, we're much closer to hand to understand the problems and have that sense of community. Although in* [redacted] *it's not hard to do that. So there is a* [redacted] *community, but saying that underneath that there is a heart which is* [redacted]*, I think…..*

The aims of 2b to market the brand internationally has resulted in higher than normal brand recognition for them. This early investment is now paying off and although the funding has been reduced so has the cost of marketing. 17 years ago when the LSI was first launched e-marketing and social media did not exist, these forms of marketing cost nothing compared to producing quarterly newsletters to distribute nationally and internationally, which they did early in their life cycle.

There have been many successful brands that due to a changing funding, economic and political landscape have been allowed to die. 2e is one of those brands. It was considered hugely successful while in operation and connected a large regional cluster of companies and academic organisations, bringing information and KE to all at no charge. In the Literature Review chapter we discussed the fact that many of these publicly funded LSI have a caveat built-in at the onset, that they must become self-financing after the period of funding is completed. 2e failed to secure funding to continue to operate and had to accept it had come to the end of the line.

5.4.5 *Understanding the factors for success*

All of the Case 2 LSIs were originally created to facilitate KE to bridge the divide between industry and academia and to help grow their respective clusters. Over time however the older LSIs have either evolved into something new (2a) or provide a reduced service to the sector (2b). 2e as discussed previously did not survive beyond the time of their funding period. They had received funding from the local economic development agency and from the local council and a few of the universities within the cluster. They were never allowed to market themselves internationally and therefore had no bandwidth outside of Scotland. Was this a crucial missing ingredient?

> *2e: We didn't have much of a profile outside of [redacted]. We did have traction with [redacted] offices globally, so some of those offices used to receive the [redacted] newsletter and they gave us feedback*

and they thought it was really useful, but in terms of an international brand it wasn't tremendously huge.

Although 2e and 2b (from 2005) were not allowed to do international marketing, [redacted] did some of this on their behalf. A question that has emerged is, was taking away the ability for these LSIs to market themselves international resulted in 2e's demise and the loss of engagement with the SMEs within their cluster and therefore their perceived value to the business community?

2a and 2d continue to market themselves, which effectively means that both businesses and academic organisations within these LSIs are being promoted internationally. 2a has signed specific memoranda of understanding with a number of international LSIs and economic development agencies, with the specific aim of raising the profile or all the organisations within its cluster and to facilitate smooth collaborations and business interactions. 2a has similar arrangement and in addition has membership of a number of European and other partner organisations.

> ***2a:*** *On the International front we talked* [redacted] *and worked out an agreement with them and now we attend Bio each year. We also have relationships* [redacted]*, and others in Europe. This enhances our membership with companies from these international companies who are in turn members of these international cluster organisations. Just last week we had* [redacted] *who were over to find out how we work and how we do things. Which means we are well known and respected. Other than those types of activities there's loads of stuff going on.*

Within the [redacted] a new Cluster Network Organisation has emerged, it is called [redacted], I was unable to organise an interview with the LSI at the time of the data collection interviews. 2a who is a business partner of [redacted] discussed the following:

2a: [redacted] was created from a development agency. They have 500 plus members between them. They were asking how they go from a regional non-paying organisation to a membership one, charging a membership fee. We discussed what the added value would be and said that they could be part of our purchasing consortium. [redacted] emerged about 18 months ago but they don't have an international focus.

It will be very interesting to see if the fact they don't have an international focus will impact on their membership and their alliance with 2a. 2a was clear that their members could determine the kind of services they required and they believed this is where their value lay.

2a: Members have to decide if they can justify the spend on membership therefore; membership is a good measure of our value.

When asked if they had considered becoming a similar organisation to 2a in order to prevent themselves from closing down, 2e had this to say:

2e: We enjoyed a respected position in the community and that was because we didn't have a subscription model. I think when you have a subscription model you get too much buy in from people who are paying for the subscription. The universities will never contribute as much as SMEs collectively and therefore you'll be constantly be working for the customers who are paying for it. Doing what they want as that's what they are paying for

MEMO – barriers to why they didn't go down the subscription path

An important factor to SMEs working in the life sciences sector are international markets. For many companies their greatest markets are overseas. This would eventually have ramifications for any LSI who is not working internationally or who do not have partners who deliver this service on their behalf.

The UK Government has put a huge emphasis on helping our companies to reach overseas markets and with the Brexit vote in 2016 and the strength of the pound being reduced, exports have been seen to have increased. This will have positive consequences for the LS sector overall.

5.4.6 *Understanding the expectations of stakeholders*

The LSIs that were locally funded by the local government and universities it meant there was an expectation that they would operate exclusively in that local region. This is an alien way of thinking and working with many of the scientists and business professionals working within the LS sector. LS reaches beyond borders. The experience of the interviewee of 2e reflected this phenomenon.

> *2e: Working locally in Scotland seemed bizarre to me, prior to [redacted] I was connected to people in [redacted] at [redacted] and the EU bio networks and it never dawn on me that I would have to only work in Scotland.*

However, the interviewee from 2b who is not a scientist and where the LSI is funded from the local council, believes that staying local has been key to their longevity. This parochialism has not always presented them in the best light with the business community across the region.

> *2b: Some of the industry players on these boards don't like 2b [redacted] This is because we're not seen as team [redacted], but we have been successful at promoting ourselves, but we are absolutely team [redacted] and that's always been the misunderstanding.*

When asked to join a more countrywide approach to LSIs in [redacted] they were pushed to consider what the benefit would be to the local region. The expectations from the local stakeholders in 2b had to be considered first.

> *2b. So why would we put 20K into something that wasn't promoting [redacted].*

So from the customer's perspective for the Case 2 LSIs the expectations should be looked at from the perspective of academia and then business.

Both 2b and 2e were expected to identify research worth promoting from the academic community. This is also the case for the French LSI they would market the research being done in their LSI, however, 2a as noted previously had very little interaction with the academic community once the merger had taken place and the new self-financed model had emerged.

2e: The expectations from academia were that we would have the quarterly meetings with them and provided them with updates, they wanted to see their work getting the PR and the academics getting the exposure. We very much would take from them what they made available to us , so none of them could really say none of this ...a few times they would say "this is not fair, this university is getting way more exposure than we are" and our counter argument would be 'then give us some more stuff'.

The expectations from the business community varied between 2b and 2e. 2e said there was an expectation from the SMEs that they would get a case study written about them and then 2e would promote them

2e: The business perspective, we did the same sort of thing. So we did case studies for them, we did PR for them and introductions and the international awareness raising that we did.

2b worked with their funding partners including the universities, specifically their Research and Innovation Services to assist with any commercialisation requirements.

2b: It's all about growing into something bigger, but underneath that its identifying what's needed for that, so that can be support in infrastructure it can be lab space, so that's where we would come in. So that's why we work with [redacted] to help them achieve their commercialisation goals.

The 2b LSI sits within the local council who are the main funder and therefore this LSI has an expectation that will impact on economic development within their region.

2b: For the funders it's about their expectations for jobs and growth.

All of the Case 2 LSIs including the French one have an expectation from the Government to help grow companies.

2e: from the government perspective we met with a couple of government advisers who would advise in [redacted], on diff issues.

2b: The stakeholders have an interest in growth, so from a government perspective and from a business perspective it's about growing businesses

Like Case1 LSIs the Case 2 LSIs may have funding from the local or central government, therefore the expectations are linked to growing companies and increasing employment in the local region. Interestingly is the LSI that is a self-financed membership organisation and who has the most involvement with the large companies in their LSI are providing fewer services that will focus on these economic targets when compared to those receiving local government funding. This is because the companies are expecting to get value from their membership fees and recieve value through procurement and other services where the value is derived by utilising economies of scale.

Reporting on targets met and successes generally for all these LSIs has been difficult. Capturing anecdotal evidence has never been easy. 2b discussed this issue and how they were exploring new ways of data capture which would show the value to the LS community, as well as to all their funders including the European Regional Development Fund (ERDF) that the LSI receives. 2e explained that reporting on successes was extremely important to them to justify their existence.

2b: It's more difficult to do that, but we do know we need to say and show what our outputs are.. Our outcomes, so saying that several people attended is fine, but what did that actually mean? We are looking at clever ways of doing this, like quotations from people, which is kind of the next step really.

2e: Yes we did but that was because we had to as it was part of our metric. A lot of the time it was a long process from introduction to actually doing something

2e: *……….. we were able to demonstrate through interviews with individual people that we were helping to increase the number of people employed*

2e: So we had economic drivers eg numbers of FTE positions created then we had more soft metrics around the number of events and the split between the attendees between the balance between academic vs NHS vs industry, the number of articles, pieces of PR , PR that's been picked up and circulated through a wider press and the number of cases we'd produced.

5.4.7 *Assessing how realistic commercialisation targets are*

When looking at the data gathered for KEC for these Case 2 LSIs it's actually difficult to see how they could effectively meet any commercialisation targets. The KE element of the KEC is the primary occupation for these LSIs. 2b had said it succinctly that their purpose was not to directly help in commercialisation but to help facilitate others who would be better equipped to do this part, like the TTOs.

When thinking about commercialisation in LS it involves IP held by universities and academics, which means the process of spinning-out a company can be very contractually heavy and complicated. These LSIs are very good at facilitating tacit knowledge exchange as they host a number of events, including both scientific and social networking types of events. The mixing of both types of events means that entrepreneurs can engage with the scientists in the hope that a spark is ignited.

The LSIs have a specific function in helping with developing skills and closing the gap for many of the smaller SMEs in their LSIs. These KE events are varied and include skills in project management and other management areas in contracts law and IP.

2b: New companies come in they always want new stuff, esp if we have new spin-outs they come to everything that they can because they want knowledge and skills. Especially if the sector is calm, you may not get the same attendance, but there's certainly lots of interest in Project Management Training and other things they need for within their companies. The scientist want presentation skills for presenting whatever. We wouldn't do it if there was no take up.

2b: Where we add value is by getting everyone to come along. It lowers the cost across the board and sometimes they get that interaction with the community that they wouldn't otherwise get.

2e: We also did a whole seminar series on IP and patents, which I know we got feedback on from one SME that found it incredibly useful to send their staff to, so that their staff were made aware of when they were developing an innovation. What do they need to do to make sure that innovation was protected and to make sure that knowledge was recounted to clients?

5.5 Results, Analysis and Discussion from Case 3 LSIs

5.5.1 *Case 3: Research Institutes and Innovation Centres*

These include the following:

- Rothamsted Research is a research institute working in agriculture based in Harpenden, just outside of London. It is the oldest agricultural institute in the UK. It is funded by the Laws Trust and is a BBSRC strategically funded institution.

MEMO – The BBSRC has established that there is a clear distinction between innovation centres and incubators. This difference being that an innovation centre will be in close proximity to a world class research institute.

- RoCRE is a newly built innovation centre that is located next to Rothamsted Research Institute. The building was funded by the BBSRC, the Laws Trust and Rothamsted Research to house companies that want to be located near to a world class research institute.

- Plant Impact, is an SME that relocated from Nottingham to Rothamsted to be close to the academic researchers.

MEMO – this is not a LSI so the researcher will not be using this data. The interview was carried out with the idea that customers would be able to provide some insights, however, it was clear that the information gained did not add to the data in any significant way.

- BioAster, is a research institute that is focused on infectious diseases that is based in Lyon, France.

5.5.2 *Introduction*

After reviewing the LSIs in Case 3, it is clear that although 5 interviews were carried out, there were only 2 different LSIs explored here. The researcher while working at the BBSRC worked on a number of other research and innovation campuses. The BBSRC were keen to promote these new infrastructure models as being significantly different to traditional incubators (Case 1 LSIs). The rational for this distinction was simply the fact that all of their innovation centres were located in close proximity to the research institute that they funded. Some of the data gathered from this period will be covered in the section on observational data later in this chapter.

5.5.3 *Bridging the divide between industry and academia*

The 2 main LSIs in this case are both relatively new. Both the French and British Governments have identified that investment needed to be made in helping to commercialise innovative technologies from the research base. 3a was built as a new research institute and opened its doors in 2013, the model differs from the 3b and 3c model, 3b is the research institute and 3c is the new innovation centre (similar to an incubator) that sits in close proximity to the research centre which happens to be the oldest agricultural research institute in the UK. 3a does have a KEC function built into its model, however, unlike 3b/3c the incubation of any innovations is done in-house.

3a has a specific ambition to build new companies and to help them grow.

> *3a: Academic invention which has already been developed particularly in France but not necessarily in [redacted]. There is also the development of improving the applied infrastructure of applied research in [redacted] by building a strong [redacted] that can help multiple companies SMEs and large companies.*

3a aims to focus on how they as an LSI can provide innovations and services to help companies develop and grow further.

> *3a: Strategic aims including assisting industry to better develop products, with a public health perspective, but also from a commercial prospective to improve the industry aims.*

> *3a: We can also perform contract research for partners and in that case the IP, belongs to the industrial partner*

3c will maximise its location to help create networks that will attract companies.

> *3c: Yes that's correct, we work with industry partners, SMEs and other universities. We will act as a central hub and hope that some of the SMEs will relocate here*

Both of these LSIs are focused on the bridge between industry and academia.

5.5.4 *Recognising the Power behind the Brand*

LSI 3a is a relatively new organisation with a new brand. The founding members include large pharmaceutical companies with well established brands. 3a has said that they will use these more established brands to bolster their own brand.

> *3a: What we have are significant brands that are the brands of our founders. So Institute Pasteur for infectious disease has a very strong brand.*

3c has a similar strategy for strengthening their new brand, they are positioned to use the more established brand from 3b to their advantage.

> ***3c:*** *We have been careful with the branding. The* [redacted] *brand has been treated as an identity within the* [redacted] *brand.*

There is nothing unusual here, leveraging the new initiative against a more established brand is common practice in organisations found in both the private and public sectors. This was seen in the data from 1b and 1c. 1b was the new incubator that was built on a site in close proximity to 1c and was able to leverage the branding from 1c to attract new companies and funding.

5.5.5 *Understanding the factors for success*

The interviewees from LSIs 3c and 3d explained that their departments are both fairly new within the established research institute and as 3d explained the work that he and his KEC department do was already being done within the research institute, although in a much smaller way prior to the opening of the KEC office. For both the Case 3 LSIs it is important to have effective engagement with the academics within the research institutes,

> *3d: We are a fairly new office and our interactions with the scientists have been very positive.*

> *3d: We are a small institute and are therefore very close to the academic community plus we're not obscured from them by various layers of bureaucracy, so I would argue we are close.*

> *3a: Our inputs with academics can range from simple consultation to managing a bioassay work that they conduct*

The interviewee from 3c wants to have more access to the academics within the research institute at 3b. He is effectively seen as the incubator manager by the academics and although they are friendly enough, probably don't see any need to get involved.

> *3c: I have a good relationship with the heads of the teams but not sure how that's getting cascaded down into the various teams. Researchers are very single minded and focused, so the challenge is to let them see that the money being spent here is of benefit to them.*

The incubator building was built on the premise that it would be filled by companies and spin-outs who want to locate close to academic science taking place within the world class centres of research excellence and that engagement and collaboration between the science base and that these businesses would take space within the innovation centre/incubator. For interviewee 3c he understands that knowledge of the science taking place is an imperative for this to happen as he can then do brokering between the companies and the academics. This is a key ingredient for the 3c LSI to work.

Engaging with industry is equally important to these Case 3 LSIs. For 3c this engagement will hopefully attract companies to relocate to the campus.

> *3c: Yes that's correct, we work with industry partners, SMEs and other universities. We will act as a central hub and hope that some of the SMEs will relocate here*

> *3c: I'm growing a network within the SME world and I'm using networks to help me do that. So I'm going to the [redacted] world and I will be speaking with various SMEs. With the corporate I'm reliant on [redacted] to allow me to do that because they have relationships with certainly 5/6 [redacted] companies and as they come on the site giving them information as they come out of meetings and actually giving information to the scientists themselves.*

3c understands that the research institute has a long history with engaging with the business sector and wants to capitalise on these relationship in order to help 3c achieve its aims.

For the 3a LSI they have a mission to educate and help the business sector to grow. They can also provide services to industry that will enable them to become stronger and more robust

> *3a: Strategic aims including assisting industry to better develop products, with a public health perspective, but also from a commercial prospective to improve the industry aims.*

> *3a: We can also perform contract research for partners and in that case the IP, belongs to the industrial partner*

5.5.6 *Understanding the expectations of stakeholders*

Because these Case 3 LSIs were relatively new LSIs there was some confusion and reluctance from various stakeholders to engage with them.

> *3a: I would say the major barrier to* [redacted] *is that it is a new model and it's taken a while for both industry and academia to understand what it's about. It's not just a grant to industry as industry originally thought. It's a joint investment by the government to develop applied research.*

> *3a: It took them a while on the academic side to realise that* [redacted] *is not a competitor and brings money and technology to the party to help with the academic inventions, but as a quid pro quo the academic has to cede IP*

> *3a: A lot of people working in TTOs come from industry and when you come from industry what you're doing is fundamentally of great interest to your company to get the best deal. So you find often that TTO officers delay things and they want to maximise the potential return. Often they're view of the return is not realistic given where it is. Even when these people have come from industry. They emphasize too much the placement aspect of making sure these industrial partners pay enough ….*

Expectations from the funder of 3c would be that based on 3c driving industry and academic interactions that would spark innovation that would then facilitate commercialisation, however, this is not a key driver for either of the 2 sectors. As discussed on ingredients needed for success 3c needs to engage with the academics to effectively broker interactions between the two sectors. The experience of the interviewee is that companies want to speak with other companies.

> *3c: If you speak to companies down in the* [redacted] *parks they will tell you that they have very little interactions and business engagement with the university. They are more interested in talking B2B rather than business to academic and that's why the clustering actually works, the other thing is they were the first to do it and they know what they're doing.*

Another reason 3c has to manage expectations from the funders at 3c is because of the competitive nature of the business. The interviewee also believes that having a sector specific LSI might actually work against them, however, only time will them if this is actually the case.

> ***3c:*** *: Barriers are there are market forces so people may not chose to go here they may choose to go somewhere else, they may chose a non-sector specific cluster, the geographical area, our scientists don't get it.*

3c knows that the incubator space has been built and funded on the premise that companies want to locate close to the great science base, this expectation must add to the pressure in convincing suitable tenants to locate there. We've seen from Case 1 LSIs that what is important to tenants is not just the science, it's the facilities and offering generally of a raft of services. On top of this there is the added extra of networking opportunities with academics working in the field. The idea is that knowledge will be exchanged.

> *3c: They (plant Impact) have the facilities of a much larger company that's why they're here, their growing but their competitors are very big and by being here they can.*

The company believes that they will be able to grow because of this location and the proximity to the science base.

For 3d the customers expect that the researchers will come up with novel innovations that would help to improve their productions and farming methods.

> *3d: The end users the farmers etc believe that we are churning out research by the bucket loads that we could and should be using to influence best practice on the ground. And because they are not changing their best practice on a daily basis means that there is somehow a failure in the system.*

For 3a the founders, funders and Government bodies include all of those rolled into one. The main expectation is to help SMEs where 3a can. The LSI itself has the objective to carry out high quality science

3a: they operate more in this area of economic development and helping SMEs to develop etc..

MEMO – as part of the discussion of expectations from funders

3a: There is as I said at the beginning one of the objectives is economic development for the region which could mean simply for example a programme with an industrial partner, we create a new technology platform at [redacted] *that can then be made available to SMEs, that one example, so in other words they've created something new which didn't exist before as a result of the project, which also means that the industrial partner will have access to it too, but it could also be a spin-out company.*

3d believes that the KEC department is able to manage expectations from the funders/Government bodies with whom they report to. He believed they took a long term view on achieving their objectives and the only issue was developing ways to report achievements.

3d: I don't see an expectation they understand what we can't and can do. The gap maybe about money. They understand it's a long term thing the difficulty is trying to measure. They don't necessary have a mechanism to get the message out there about what a good job we're doing.

5.5.7 *Assessing how realistic commercialisation targets are*

3a because it's a relatively new LSI has a role in KEC. They do KE in that they have specific expertise in certain areas where they can deliver training.

3a: There is a second remit which is wider which is that we have a significant training and teaching objective. Because we're working in very applied areas, so for example the application of MRI in infectious disease, so MRIs are not in areas where you can work in infectious disease, because you need to have biological protection . So we can also train people to use MRI in infectious disease as we have the facilities and we can welcome students from other courses.

The commercialisation work that 3a do is strategically directed by the founders/funders.

3a: Involving both industrial and academic partners. There are 15 projects with value of 3million in a short period of time. Bringing disparate parties together in an efficient way of working in a collaborative project. We've *developed a standard commercialisation policy that has buy-in from all founding partners (so basically industry and academic partners) who have agreed on how research from [redacted] would be commercialised*

3a: Economic return can mean for example, if we do a project with a financial partner or with multiple industrial partners, there are specific clauses in the collaborative agreement between [redacted] and those parties, whereby if the project is successful and it leads to successful products or processes or something else, there has to be a financial return to the project, that can be flexibly written usually in the form of royalties or success fees or some other financial return. It's not just creating jobs it's a financial return to [redacted]

3a: [redacted] has objectives in KE in the sense that depending on the project it can vary. One aspect is that if we do a project that results in a new technology rather than a product, so that's usually exclusive. But if you develop a new way for screening the pharma company would want access to it but there may be an opportunity to spread that process or technology to other partners or CEA or to whatever so. There's a strong requirement that inventions that are developed by [redacted] should be commercialised to the fullest.

These policies help them to benefit as many organisations as possible within the region. There also appears to be an understanding that one of the benefits is also that of economic returns from their KEC activities.

3d was set up specifically to facilitate KEC work within the research institute. The interviewee previously explained that it had been taking place in a much smaller way with no organisational structure. The new KEC department are aiming to recruit and develop a high performing team with the KEC remit

3d: We've recently employed a KE officer to facilitate and promote KE in [redacted], it's not just about telling people what we're doing, our KE programme involves developing closer links with local farmers, with farming orgs and those who promote best practise in agriculture, developing better links with the research association and developing that so we have a pretty active KE programme.

3d: The events we do at the moment are pure [redacted] events and tend to be focused on developing [redacted] and we work with [redacted] on that , these events are focused on SMEs. There are a lot of events like this out there and we work with others like [redacted] East on events programmes *that they're doing, we're also involved with programmes run by NiAB and others.*

3d: We'll probably run 2/3 events a year other than that it's more about going out to external events and exchanging knowledge at these.

3d: We actually dev software that will help people improve farming practice, so we're putting a product out there in the market, but we would never sell such a product, we don't have the capacity to sell. Most of the technologies that do get out there, get out because of a commercial partnership and we leave the commercial partner to do the selling

5.6 Results, Analysis and Discussion from Case 4 LSIs

5.6.1 *Case 4: Sector Specific Thematic Intermediaries*

These include the following:

- The Scottish Stem Cell Network (SSCN), were based in Edinburgh, however worked across Scotland. They were operational from 2003 to 2013. A non-for –profit free membership organisation focused on Stem Cell research.

- The Knowledge Transfer Network (KTN), was divided up into many different sector networks all working nationally in the UK. They had different locations for the 15 different sector networks. At the time of the interview the KTN had been consolidated to 1 central network that worked across the innovation sectors. The LS KTN was considered one of the most successful ones and has more or less been left as it was. They are funded by Innovate UK

- The Cell Therapies Catapult (more recently it has been renamed the Cell and Gene Therapies Catapult) is a national thematic centre based in London at Guy's and St Thomas's hospital, but have a remit to work across the UK. They are funded through Innovate UK, initially for 5 years with a potential for further funding. Their aim is to identify potential innovations that have the potential for commercialisation or for further development to progress them.

- Leiden Medical School initiative. This is a sector specific network project that works across 2 different cities in the Netherlands, Leiden and Delft. They are regionally funded and operate as a bridging organisation between industry and academia, with the expressed aim of getting innovations to the patients.

- Edinburgh BioQuarter (EBQ), is based within the University of Edinburgh Medical School, They were funded by both the University of Edinburgh and Scottish Enterprise NHS Lothian, University of Edinburgh, College of Medicine and Vet medicine, SE,. Their aim is to spin-out as many medical innovations as possible in to companies from the academic base. They have 5 years funding and an initial target to spin-out 40 companies over this time. The partnership is about improving commercialisation of IP coming out of Edinburgh University and NHS Lothian, alongside that and almost part of that is helping to strengthen the BioCluster in Edinburgh. They get funding from NHS Lothian, although the majority of the funding comes from SE and the University of Edinburgh.

5.6.2 *Introduction*

The Case 4 LSIs are all relatively new, one 4a closed a year before the interview took place. It was useful to hear about what had worked, what had not and where improvements could have helped and where areas of learning from their experience were.

5.6.3 *Bridging the divide between industry and academia*

4a was perceived by both the academics and industry players in the sector as an organisation who could help them to grow or to access funding in the case of academics.

> *4a: It varied; I'd say we started out positively, the academic groups can be quite mercenary, if you can give them something or fund something for them then they tend to like you.*

This sector specific thematic network was working in a growing a relatively new area of research. The network had funding from the local economic development agency and many of the key leaders in the field were asked to participate in a number of show casing events to promote the companies and the research taking place in the region.

> *4a: I was quite sensitive too I was in a small field like [redacted] there's actually quite a small number of experts and they tend to get drawn on incredibly frequently by Government, visiting inward visits by parties from China, America, etc,etc and there's quite a lot of time and effort that the academic puts into these kinds of things or actually put in*

freely and they don't always see the outputs coming out from the other end and I was quite sensitive to that too.

4a: it tends to be the same people who are asked. It's always [redacted] or [redacted], always the same people. We were able to go to [redacted] or [redacted] and say well actually there's these guys who's working in Aberdeen and he's doing some really hot stuff, you kind of spread it out a bit too.

They were able to help bridge the divide and help with some of the demands made on the scientists by protecting their valuable time. They were able to work with their funding stakeholders to provide an effective service and were able to effectively communicate the needs of all their stakeholders.

The 4b LSI is based in [redacted] and is a project set up and funded to work in 2 hospitals across two cities [redacted] and [redacted]. They have a specific bridging role between industry and academia with the aim to benefit the end users, in this case the patients. The projects had been deemed to be successful and had reached a stage where further funding was sort to continue operating. The interviewee felt confident that this would be achieved.

The next LSI included interviews from four different individuals from the same organisation. The roles of each interviewee within the organisation varied and provided a different perspective on their function and ability to bridge the divide between industry and academia.

Initially the researcher had believed that this LSI had a model similar to a TTO and had been prepared to allocate it to Case 5 LSIs, however, it became clear from the interview that 4c,d,e,f consider themselves as a sector specific thematic LSI as they work exclusively in the field of medicine. The funding for this LSI had another six months to run at the time of the interview.

4c explained that the aim of the LSI was focused on the KEC activities and that they spent a lot of time engaged with both industry and academic stakeholders. They believed they were bringing business practises to academia therefore bridging the divide and sometimes that was met with negativity

> *4c: Its horses for courses some will feel that its working for them and some will feel that they're not particularly interested in getting involved in commercialisation activity and for those its fine, so some embrace it with open arms and some carry on to do what they've always done and some are slightly negative about getting involved in anything that's commercial.*

When the interviewer asked if he had better engagement with the younger academics within the medical school he was quite keen to point out that those who had initiated and supported the creation of the LSI were themselves academics from an older generation.

> *4c: Yes I would agree that the younger academics are more commercially aware. However, if you remember the whole of the [redacted] project was driven by the senior academics in the college, so the likes of [redacted] and [redacted] [redacted] [redacted] is head of the college and [redacted] has now moved on to be a Vice Principal for research service and still does research, so there's two extremely senior academics who have totally and utterly got it and who felt that we needed to be doing more commercially driven work. People like [redacted] the head of the [redacted] totally gets it as well. I'm not sure that age is necessarily the deciding factor I think personality is. I think some academics like to feel that they're doing pure research, which is not being influenced by industrial considerations in any way and other researchers believe that you can combine the two things.*

4g had a similar experience engaging with the academic community within their sector specific LSI. They appear to choose academics with specific characteristics

> *4g: So we work with the academic base with those that we think have got the characteristics that we want to see moving forward*

4g again like 4c are very focused on the commercialisation potential of research. Engaging with the academic community has not been easy, there has been a high level of expectations from all stakeholders on what to expect from 4g and, as explained by them, a certain level of suspicion. In the past these types of LSIs like the ITI's previously discussed in chapter 2, were awarded significant funds in order to use their sector specific expertise to identify suitable academic projects to fund and to lead to a commercial outcome. The academic community were invited to put forward proposals for projects that had market potential. Once approved the academic group was funded and researchers employed. Based on these previous experiences the academic community had perhaps a different operational view of the new 4g LSI. The 4g interviewee explained that they have a different approach now and had definitely learnt from the mistakes made by the ITI LSI that was considered a failed intermediary initiative.

> *4g: initially when the [redacted] first came out there was certainly an idea that the universities would capture them as a university system or be an extension of them. So some the universities certainly the early ones we engaged with tried to rule the [redacted] Now they understand, now you're dealing with the corporate parts of the universities and not the TTOs and academics.*

> *4g: The academics are always a bit suspicious and you have to find projects that people want to work with you, find models that meet TTO and academic aspirations and at the same time the [redacted] will accelerate the project and if they're not accelerated or in fact if people don't want to accelerate things which may sound like a strange thing but some people are quite happy to go slow. So accelerating things with properly controlled trials are essential. We found there are sufficient people who want to work with us.*

Both 4c and 4g have been created to bridge the divide between industry and academia, they are both using a more focused approach, one that will they hope will create many more commercialisation outcomes. 4a and 4h also had the remit for bridging the divide, however, a lesser focus on the commercialisation of the research. This lack of commercial outcomes was possibly one of the reasons why they did not receive further funding. The two newer LSIs 4c and 4g have been created and funded by public money to focus on the untapped economic benefits that these LSIs can bring.

> *4a: If were starting now (bearing in mind the industry was a lot less mature back then) but if we were starting now we would use that money now to help more companies, more like a Spark award or pre-award.*

On a deeper analysis of this data and based on a MEMO that was written at the time of the transcription, it seems that the bridging function would work better with a mix of employees from both sectors. This would improve the teams working on projects many of which have a requirement for both sectors to be involved in the collaborations.

> *MEMO- I think that having a focus on people who have come from industry means they have no real understanding of the sector they need to work with academia! It becomes just like before industry and academia who don't have any understanding of each other's sectors. For an intermediary it would be good to have mix from both industry and academia and from social sciences qualitative and the scientific quantitative side to get a higher performing team.*

5.6.4 *Recognising the Power behind the Brand*

For 4a the brand recognition came fairly quickly for them when they first came. The thematic science of the network was part of their name, which made it easily identifiable. The other reason for this was that the science they were focused on was very in-vogue at the time of their creation. There was high expectation for innovation in healthcare from this area of science.

> ***4a:*** *The impact we seemed to get everywhere. Recognisable pretty quickly……………………………*

As explained above they did tap into a hugely successful company, the one that was associated with [redacted] and were able at least early on in the lifetime of the LSI to use the companies brand to raise their profile.

> *4a: Early on we used the [redacted] branding and we had a successful conference under that brand. It is still remembered and the values it stood for are still understood.*

4c struggled with their brand, there was a misconception as to the type of organisation they were. This general public perception of being something that they weren't was apparent at the interview.

> *4d: It was difficult to establish primarily because [redacted] means different things to different people, if we were starting again now, we would not call it [redacted] because [redacted] is associated with the science park, for example if you get in a cab and ask to be taken to the science park they don't bring them here. So the feeling is that we should have identified the branding better and made it more distinct from the science park. But then again the [redacted] is seen by other communities as not being just the science park, but the science park, the hospital and the medical school and the greater environment all the way down to [redacted]*

Those employed within the LSI were not involved with the creation of the brand name, they just inherited it. This was experienced first-hand by the researcher, who approached this LSI for an interview thinking it would be placed under Case 5 LSI as one of the Technology Transfer Office models. In reality the LSI 4c-f has elements of a TTO and an accelerator model, where they germinate very early stage ideas and take then through to the proof of concept (POC) stage, before moving them into the incubator nearby, however they were very clear throughout the interview process that they were not a model of TTO (Case 5 LSIs)

When this LSI was interviewed it was very near to the end of their five year funding and they still had the issues of perception surrounding their brand. If they had addressed the brand issue early on, would it have helped them establish themselves better and perhaps achieve more?

> *4d: No its public sector and industry who view it as the entire area. The academics view it as the hospital, the medical school and the science park. External people coming in are not sure how to view it and it depends on who they speak to first. We could have done with a better brand. It could have helped with having a different name. Being the [redacted] helped to us to differentiate ourselves with [redacted] and that was a major help.*

The 4g LSI at the time of the interview was only 18 months into a five year funding package, therefore still a relatively new LSI. One of the advantages that 4g had with regards to branding is that they have a brand that is recognised nationally as it was supported by Central Government. National promotional activities alerted both the business and academic communities to the brand and of course raised certain expectations in both sectors.

> *4g: yes that's right. It's all about credibility you see because you're known to a certain extent we were able to establish credibility by being people at ... and of course the asset that we've created here is very impressive and the more opportunities we generate and credibility, will impact on our investors who really like the [redacted] because we have a big reach into the US and Japan*

LSI 4h at the time of the interview had only in the last six months undergone a contraction of their LSI. The LSI previously had 15 sector specific arms that covered a range of sectors from the financial to digital and included 2 LS sector LSIs. They received funding for their LSI from the Government too and with funding becoming scarcer they were made to contract into one single central organisation with one administrative centre that worked across all the sectors. They still retained their brand which still had good amount of impact. The 2 LS sector LSIs had been the strongest performing parts of the 15 LSIs and many of the staff working in them were kept on to continue the work under the centralised brand.

5.6.5 *Understanding the factors for success*

Looking at the data it is clear that the interviewees had lots of opinions with regards to the elements that work and help them to succeed and at the same time those that don't work or act as a barrier to success.

The newer LSIs like 4c-f and 4g were focused on what they needed to help create new commercial entities, whereas 4a and 4h had a focus on only some of this.

A general statement about what they are looking for to create successful outcomes is qualified staff and the finance to make things happen. Another interesting point made was that they also felt that the companies they had created did better when they were located closer to them.

> *4f: Barriers: lack of cash and experienced management teams. [redacted] programme, located close to academics to us have done better. Remote companies are not as good.*

The interviewee went on to discuss in more details the issues around finance. The LSI is located in [redacted] which has a thriving Angel Investor Network community. These are individuals who have done well themselves and made money that they can now re-invest into smaller local companies. However, as was pointed out below, this has its downside too, in that it is a 'drip feed' type of system.

> *4f: That's why I say that local Angels are a blessing, but they can also be a curse because they haven't got enough capital to see the company through and the whole thing becomes the living dead and you….*

4g believes that good technologies and innovations are missed all the time because of the lack of knowledge within the TTO community. This was also identified by 3a previously who also said that the TTOs could unintentionally delay progress within commercialisation.

4g: A recent example in [redacted] as around the fact that the technology had been missed by the TTO but had been obvious to the commercial sector. In fairness to them it's about specific knowledge and about the potential for a technology which you get from in-depth knowledge.

4g: There's an overvaluation of early stage research, by and large. The values can't be achieved.

4g: We only work with TTOs to get high level messages. I think we would be working with the academics directly.

(MEMO this shows a similar message from two different LSI model types (taken the from previous section))

3a: A lot of people working in TTOs come from industry and when you come from industry what you're doing fundamentally of great interest to your company to get the best deal. So you find often that TTO officers delay things and they want to maximise the potential return. Often they're view of the return is not realistic given where it is.

Even 4d had something to say about TTOs overvaluing the innovation

4d: They felt it was an easier path to access the IP one of the big complaints about TTOs is that they make accessing the IP more difficult rather than facilitating it and they do that by massively overvaluing the IP that they have

5.6.6 Understanding the expectations of stakeholders

From the customer perspective there were various expectations that impacted on the LSIs. For 4a it was clear that their stakeholders from both the industry and academic sectors had a perception of what they could do for them. For industry it was signposting and introductions and for the academic sector it was paying for and hosting scientific KE events.

4a: the expectations from us from business were quite a lot actually, they wanted us to introduce them to lots of people who would use their products and services and basically were just grateful for anything they got and didn't have massive amounts of strings attached to it.

4a: From academia it was 'give us money' and to run high quality free events for everybody and pay travel awards and that kind of thing, I felt that up to a point it was worth doing that because when you needed to *use your academics for something else you could. It was the only carrot that we had.*

4c-f encountered a different set of expectations, from their funders who were the local economic development agency they inherited a business plan and a brand name. They had to spend some of the 5 years that they had of funding to educate their funders on what was and wasn't possible to achieve.

4c: When I came into this job and inherited the business plan that had been produced by [redacted] and signed off by the university, it was nonsense. So one of the expectations for eg was that we were going to spin out 42 companies in 5 years and stuff like that, so I re-wrote the business plan and part of it frankly is education and part of our culture change is as much changing the culture of our Government as it is the academics frankly so it's getting everyone on the same page.

They were able to agree on most things and both the funders of 4c-f and the LSI itself agreed on new targets in order to move forward. As the economic development agency wanted to expand their science park they needed to ensure that 4c-f continued to create new commercial entities.

4d: As part of the ongoing discussions at the time [redacted] were building the [redacted] science park and they were interested at the same time in increasing commercial outputs from the college of medicine because primarily [redacted] was going to be a LS park in particular Translational Medicines oriented science park.

For the 4g LSI the expectations were tied in with their targets and agreed upon from the onset of the project. Again these targets were expectations on the income and matched funding they would need to get in order to succeed.

4g: The second 1/3rd is expected to come from external forms of funding like TSB and Horizon 2020. So its collaborative R&D funding competitively won or judged by some criteria. The last 1/3rd is expected to arise out of contract research.

4g: Enthusiasm is high at moment. We've created a vision and a plan that everyone can buy in to. We are recognising stakeholders and how they react is really important. We recognise we are part of a larger innovation *programme. We have the structure in place for industry and academic to feedback as to whether we are performing.*

From the Government bodies side of things the expectations were also high and in some cases like for 4a unachievable.

4a: After the 5 year period they were expecting there to be a multimillion pound investment into the [redacted] opportunity in [redacted]. Well if you're only putting in a million quid that's not going to happen. More would allow us to identify strategically research wise what we should be putting in the infrastructure which they are now doing. They have the infrastructure there with GMP. They thought everything was going to happen in 5 years. This was quite difficult. They wanted a ROI in that time.

This is a stark warning from the experience of 4c, expectations need to be curbed, and need to become more realistic and the fact that much of the hype does not become a reality should be an eye opener.

4c: I think that [redacted] in a very simplistic view of life thought Great if we put a campus here and the university is on site and we put up a multi occupancy building that people can move in to, people will just come, well guess what there are sites like that all over the world and all over the UK now and unless you differentiate it in some way that's not going to happen.

4c: There has been massive overselling of the promise of LS in the early 1990's and a lot of things didn't come through.

5.6.7 Assessing how realistic commercialisation targets are

LSIs 4a and 4h both had a KEC remit, however, were not only focused on the commercial outcomes but on the exchange of scientific knowledge both in and out of their LSI.

4a felt that they could manage funding SMEs in a much less bureaucratic way that was welcomed by the SMEs they engaged with.

4a: with the ERDF funding we were able to support the small start-up companies which wouldn't have made it otherwise they would have struggled

> *4a: With SE and pump priming they had so many strings attached to the money received whereas with us if we gave them £1000 to test chips or something, they couldn't believe there were no strings to it and that would allow them to go on and get the next round of funding.*

Reviewing the data from the 4c-f LSI it is clear that they feel very passionate about the KEC aspects of their work. They clearly have an understanding of how to do the work effectively in order to reach the targets they set out for themselves. Many of those who were interviewed at this LSI have come from industry and although previously discussed that this may in fact be a disadvantage when understanding academic drivers, it appears to be invaluable to the company creation function of the LSI.

> *4d: We would like to think of ourselves as more of an accelerator so that is more to develop IP assets along commercial lines*

> *4d: the important translation of that research is its all got to be commercialised if you don't commercialise the work it's never going to get to the patients.*

> *4c: So we have to be very proactive because we come from a biotech background and we're used to deal making basically and we treat this in exactly the same way. So most TTOs don't function in this way.*

> *4d: But is not just KE, you have to add value, it's no good like in the old days saying, look we've found something here does anybody want to buy it?*

Tied into the KE are the events they host with the objective around the commercialisation of innovations. One clever event was the annual competition where the young academic teams would create a company with guidance from LSI mentors. The companies would if they succeeded get finance to spin-out of the University. This KEC activity provided training in management skills as well as support in product development.

> *4d: Yes we do have seminars, we bring experts in who discuss the advantages and pitfalls of going in various ways. What has been very*

successful, is that we have an innovation competition every year, where we invite people to apply and things are short listed and we assign people from the team to work with them to explain the commercial programme and to get things commercialised that's been very successful. We get many repeat customers, people will come with an innovation competition entry and even if it doesn't succeed they will come with another one and another one

Emphasised again here the difference between what this LSI does and what a TTO LSI does.

4f: so in terms of the spin-out process, its finding funding, finding management team, appointing management team, finding investors, negotiating the terms of the deal and negotiating the terms of the licensing deal so it's fair to all. Helping them find advisors, we do all of that, <u>so to be honest we are a million miles away from a TTO</u>, we add a huge amount of value to these companies.

The 4g LSI didn't specifically have a remit that included KE, after discussing this with the researcher 4g said that they had started to do this and he understood that KE was linked to commercialisation

4g: We don't have a KE department it's embedded. We do joint workshops with HI and we've had a lot of success. We work out how to do something and then we disseminate with a 1 page. We do have conferences and sponsor them. We have one tonight that we co-sponsored and co-organised. The world stem cell conference is annual conference and GE healthcare and investor day. So it's hand in hand with the commercialisation activity.

5.7 Results, Analysis and Discussion from Case 5 LSIs

5.7.1 *<u>Case 5: Technology Transfer Offices</u>*

These include the following:

- Research and Innovation Services (RIS) based in the University of Dundee. Although RIS works across all sectors, they are very focused on the life sciences and medical innovations from the University.

- LURIS, is the knowledge exchange office for the University of Leiden, Holland and the medical school based within the University. They represent all scientist by helping to find partners and research funding. They deal with entrepreneurship and legal matters for the academics.

- Knowledge Transfer Centre (KTC) at St Andrews University, provides a one stop shop for academics in entrepreneurship services. In 2008 the KEC function was moved to the KTC with 4 staff.
- Edinburgh Research and Innovation (ERI), is a standalone limited company that is the central TTO for the University of Edinburgh. It covers all sectors, but has a particular focus on life sciences and healthcare.

5.7.2 Introduction

These LSIs have been around for years and have not always been perceived as providing any value. They do however recognise that changes are needed in many areas they work in. Clever ways of bridging the divide are needed.

5a: TTOs have been bashed for years due to poor data out there, it depends on what you're doing for the academic and if you're liked, the TTO is there to serve the University…

5b: There is a culture change with PIs and postdocs being asked to think about what the impact will be now.

5.7.3 Bridging the divide between industry and academia

So what strategies have they employed to better facilitate the engagement and the relationship with the academics?

5c: CRC model where we embed people in the schools has been running for 12 or so years. It's up for review just now in terms of how we make it more productive, but through close engagement and that means embedding our people next door to scientists brings the whole KT agenda to the surface, how inclusive are we able to be? I guess with a broad spectrum office we do a lot, if a scientists has got a consultancy or research query or commercialisation query we channel it through one area, we can backfill it to some extent, so, we're able to be fairly inclusive, *there's maybe somethings we just don't cover and sometimes this can cause issues because we're there we can do something which we can't.*

Embedding expert staff to be close to the academics. Constantly reviewing these strategies will help to identify where the areas for improvement lie, which is something they seem to be doing in the [redacted].

Working closely with the academics is an imperative for these LSIs, however, at the same time as doing this they must also engage and develop relationships with industry. The TTOs do have a role in bridging the divide between sectors and appear to find different ways to achieve this.

5a: We have long relationships with a number of Pharma companies which is unusual, we also have a lot relationships through the innovation portal.

5b: We have 2 staff who are funded to be outward facing engaging with industry. We have had funding from the EPSRC for this activity and have 35 projects with 28 engagements with companies, this would never have happened before we got this funding

5b: It's a frog kissing exercise to find an SME who needs a problem solved and where we can in academia can help them

Problem solving for industry seems to be helping theses LSIs develop their long term relationship with industry partners.

5a: New models of working with industry is one of our successes. We're too small in [redacted] *to be thinking about just* [redacted]*, many of our companies go out and export. Most SMEs don't have the resources to develop new technologies*

5b gave an example of how they managed to engage with an SME whose mother company was a big US company and instead of encouraging this relationship the 5b LSI was shut out. The local economic development agency took over and excluded the TTO LSI from further engagement as they account manage these large companies themselves.

5b: We had helped a postdoc working on an innovation to link with a local company and got them a follow-on voucher. Once the voucher stopped or we could not do anymore in the way of finding funding our links to the *company became very much diminished. The company who had a mother company in the USA was seen by [redacted] as a priority account managed company because of this. We are kept out of the loop.*

5.7.4 Recognising the Power behind the Brand

These TTOs are situated or linked to Universities. There has been some success for TTO because of the reputation and brand of the University themselves.

5a has used branding to its's benefit at international conferences and events. While writing the transcript the researcher wrote a memo about why they appear more successful than one would predict for such a small University. The TTO benefited from the regional Cluster Network Organisation, [redacted] who had a remit to market the science from the University in the early stages of its own life cycle, they did this very effectively, and this has had lasting effects and benefits for those associated with the [redacted] brand. They promoted through marketing channels the high profile science and scientist within the cluster.

5a: No , but we do marketing support and will do more with a new post we've had approved from Uni [redacted] has a brand. For example when I go to Bio, people don't turn us down for a meeting because we're [redacted]

MEMO- my thinking is that because of the marketing done by [redacted] or is it purely the Universities reputation or a combination of both.

5.7.5 Understanding the factors for success

This an extremely difficult thing to determine here and no one size fits all, each TTO appears to operate differently. Generally speaking they are there to help protect the universities IP and to help drive KEC.

Some of the ingredients for success include helping to create momentum within the LS cluster locally.

5a: If there's enough companies that people can work for like [redacted] then it will attract biologists. So building activity that will bring people in to *live here. So that's not such an issue. We have created the bio cluster here and people have started to move between industry and academia, this is the same for managers as well as it gives them more opportunity*

They use case studies to capture their successes.

5a: we have anecdotal stories, plus getting repeat business. How many times have they come back and done something?

Some of the ingredients that are in short supply according to 5c are:

5c: The main barriers: (1) investment fund; (2) lack of strong management teams (3) transition funds

One of the key hurdles for success according to 5d is the lack of opportunities, which means when an opportunity arises, everyone is after it. This means that there is competition between different LSIs in the same regions.

5d: We have a fragmented landscape in terms of strategies. All vying for same ops.

Therefore it must be important to attract a wider range of opportunities. Although finding an exact match with what industry is looking for and what academia is working on might be difficult.

5d: It is not always easy to find companies with similar interests in the research here, so we have a mixmatch and it has become the biggest barrier. So what the companies are working on and what the researchers are working and the outputs align then that's great but we have a gap.

5.7.6 Understanding the expectations of stakeholders

These Case 5 LSIs had little to say about managing expectations 5c just simply said yes we do!

5c: We manage expectations with all our stakeholders

The interviewee from LSI 5d explained that in his experience there was an expectation from the academics that the TTO would handle all the commercialisation of their research for them. They appeared to be happy to hand over the reins to the TTO with little involvement from them.

> *5d: The scientists have an expectation of the TTO that we will commercialise it. They think we will have 10 companies looking at the technology without them being involved. I found this over the 6 years that happens. So we need to make them aware of what they can expect from us.*

5d believes that the TTO does not have all the answers and he would like to see the academics getting more involved as they are the experts in the field not the TTO managers.

> *5d: If I have 10 technologies and I engage with 5 companies and 1 leads to a collaboration is that a good thing or a bad thing? What are the expectations of the government, the scientists and the University? We haven't been able to pick the winners, it's not something we have been able to do. So it's about trying. So lately I have been thinking about how I can stimulate the scientists to become more involved.*

5.7.7 *Assessing how realistic commercialisation targets are*

We discussed earlier that the LSIs were looking at different strategies for engagement, this strategy impacts on their commercialisation targets

> *5a: So strategic corporate getting co-operations. Set up a relationship with half a dozen major corporates around the world and set up a real relationship with them and do it multi-stranded with placements, CPD, enterprise research excellence and licensing and populate the company with connections with [redacted]. Eventually something will come here because of it./ So multidisciplinary relationships with major corporate, that's what we're looking at.*

5c explained that as part of their commercialisation activities they encourage and support early stage incubation of ideas.

> *5c: We do have in school incubation. We encourage them into TEC managed incubation, therefore they get a lot of the service stuff is handled for them. In terms of pricing it is quite low in year 1 and goes up in year 2*

and as the company becomes more commercially viable in year 3 it goes up again. We want them to move on then.

They have a system that encourages entrepreneurship from across the country and they provide the same level of support to everyone who participates. 5c wanted to see good practices spread out to everyone and as 5a pointed out the region is too small to be successful in just one city.

5c: We have a programme here of supporting graduate and undergraduate students and Enterprise Campus is focused on any postgraduates from across [redacted]*, they can have access to the same level of support that people in* [redacted] *currently have, which is a great thing.*

5c: I think we need far more sharing of best practice between institutions, far more of shared working, I think Enterprise Campus is a good example of a programme that works, we're now rolling it out and every University can participate. So [redacted] *and* [redacted] *are geographic hubs and we* [redacted] *clearly, so between the 3 of us we cover every University. More of this kind of thing is what's needed, to roll out good practice.*

5c: We bounce things off them. We also have our own investment fund. Created by money made on one of university spin-outs, so we have a £2million fund, which allows us to invest hard cash into some of our spin-outs, sometimes we can help. We engage investment professionals looking at technologies they can decide without input from our office. It is not an emotional decision, it's about whether it makes money which is it a good thing.

Some very good and innovative ideas for facilitating commercialisation from the TTOs. Most of the TTOs around the UK have now employed a KEC lead within their TTOs. This is probably because of the policy work done at the research councils to encourage this strategy within TTOs. This links directly to the return on the investment of tax payer's money on research. The research must be more focused on a commercial outcome.

5.8 Analysis from Observational Data collected

5.8.1 *Introduction*

The observational data includes a number of talks that were attended including three specific talks on different areas that affect different intermediary models from the Innovate UK conference that took place in November 2014. One that looked at Research and Innovation Campuses and the clusters these intermediaries are a part of. The other two conferences are Bio2015, where the researcher attempted to collect primary data and the PraxisUnico Conference 2015 in Dublin.

From: Innovate UK Conference 5-7 Nov 2014: (Presentations and slides can be downloaded from: http://innovateuk2014.policyreview.tv/conference/993.html)

What UK Innovation campuses can offer you? (Day 2, 2.45pm)
Chairs: **Tim Bestwick**, Executive Director of Business and Innovation, Science and Technology Facilities Council; **Celia Caulcott**, Executive Director, Innovation & Skills, BBSRC;

Panel:
Mike Lawton, Oxford Space Systems;
Will Spooner, Chief Science Officer, Eagle Genomics;
Alison Johnson, Director, Food Forensics;
Heather Dunlop-Jones, IBM, Distinguished Engineer and Chief Technology Officer.

5.8.2 *Synopsis of the Discussion on UK Innovation campuses*

This panel of speakers was chaired by two Research Council directors, one from the Science and Technology Research council (STFC) and the other from the BBSRC. The four panellist were from companies that are located in the various Research Councils strategically funded Research and Innovation Campuses (RICs). There was emphasis made on raising the profile of the benefits of locating in one of these RICs. Celia Caulcott from the BBSRC, said that "*they were a carefully constructed environment*".

The four panellist were introduced to the audience. Most went on to describe that their reasons for locating within a RIC was not simply to be close to the academic science, additionally it was infrastructure like computing power for Eagle Genomics and a close proximity to a large teaching hospital. For Alison Johnson, what was important was the ability to find suitably qualified graduates. Mike Lawton explained that his company had moved from Culham Science Park to Harwell Science Park because of the new Satellite Catapult opening up there and the European Space Centre location there. They were attracted to move for the potential to collaborate with these organisations.

The IBM panellist Heather Dunlop-Jones said that for two decades they had been a supplier to organisations within the Daresbury Science Park which is managed by STFC. They now have the ambition to make their super computer more consumable and are now working with Unilever in formulation work, with Rothamsted Research a BBSRC funded research institute on their 2020 Wheat project. They have gained by being part of a RIC and can rub shoulders with SMEs to partner with them.

5.8.3 *The Fit with Focused Codes*

This session was hugely influential to the researcher's decision to create a separate case for the research institutes and the innovation campuses (Case 3 LSIs). The Research Councils put up a strong case for this, however, as previously noted on in-depth analysis that was required for the focused coding stage of this process it was clear that the different elements of the Case 3 LSI could have been divvied up between the other cases.

Table 17: Focused Codes (Copy of Table 16)

Focused Codes
Bridging the divide between academia and industry

Recognising the power behind the brand
Understanding the factors for success
Understanding the expectations of stakeholders
Assessing how realistic commercialisation targets are

Observational data can be applied to the focused codes we have previously used for the Case LSIs, see Table 17. The RIC assist in bridging the divide and from the notes it is clear that there is assistance to the companies located within these RIC with introductions (rubbing shoulders), KE networking events to bring people together and the possibility of tapping into public sector research funding.

The companies with the brands like IBM don't need any help with utilising the brand of the research institute. It's more the factors for success that comes across as more important to the companies here, which were outlined in the talks and include:

- Proximity to a large teaching hospital
- Super computing power
- Infrastructure
- Networking with like-minded individuals and companies
- The potential to collaborate
- Being in-close proximity to potential customers

The data collected for this research did not include that from any companies located within the LSI and on reflection that may have provided a more rounded picture of the value of the LSI itself, however, the focus of this study was on the value of KEC within these LSIs.

The RICs are themselves creating expectations within their current and potential customers/tenants base and from the talk it is clear they intend to do more marketing to raise their profile and differentiate themselves.

The cluster effect
Chair: **Will Hutton**, Chair, Big Innovation Centre;

Panel
John Womersley, Chief Executive Officer, Science and Technology Facilities Council;
Simon Andrews, Executive Director, Fraunhofer UK Research Ltd;
Professor John McCanny, Director of ECIT, Queen's University Belfast;
Naomi Krieger Carmy, Director, UK Israel Tech Hub

5.8.4 *Synopsis of the Panel Session on the Cluster Effect*

The chairman introduced four panellist from four different LSIs, each was asked a number of different questions about how their LSI impacted on the local and global innovation ecosystem. Although the panellists were not from LS specific LSIs it was an interesting talk and fed in to the research from the literature review of this thesis. Many of the LSIs interviewed appeared to be growing a cluster of sector specific companies. This ties in with the academic discussions on cluster-based economic development and innovation (Ketels and Memedovic 2008). This paper talks about the modern economic policy around clusters and the move for companies to work in cross-company interactions, therefore utilising economies of scope rather than economies of scale. This panel session had examples of how these LSIs are helping to facilitate these strategies for scope.

At the end of the discussion the chairman made a plea to the audience for continued support for the investment into the UK Catapult initiative and saying they had hardly begun and we need to follow through on them. There seems to be an understanding of the political influence on these LSI. The UK Fraunhofer director was one of the panellist and as previously discussed in the literature review (Chapter 3) these Fraunhofers have had been around since World War 2 whereas we have had a multitude of LSIs come and go. The chairman made reference to the recent report on the Catapults when he made his plea for continued support of the Catapult programme. This plea was made to the audience, however, it was likely meant for the ear of Government who are the funders of the Catapults. The longevity of the Fraunhofer's is validation of their success and can be linked to our definition of success and failure in the past and current LSIs.

5.8.5 *Bio2015 15-18 June, Philadelphia*

5.8.5.1 *Background*

In January 2015, the researcher put forward an application to host and organise a panel session as the Bio 2015 conference in Philadelphia. This was supposed to be an exercise in data collection as the conference had the facilities for live audience polling. This would have added depth to the research from collecting primary data. On the day the polling facility did not work due to a WiFi issue which meant that this effort failed to gain primary data. This effort has now been placed alongside the observational data because no answers were captured for the questions in Table 18 below.

5.8.5.2 *The Bio2015 Conference Panel Session Details*

Title: The unsung heroes - life science intermediaries, how they provide value in the knowledge exchange and commercialization of innovations

Abstract: Nearly all economies around the globe are looking to the science base in order to positively impact their society and economies. Key to achieving this is moving innovations from the knowledge base to the market. In order to overcome the challenges this presents, emphasis has been placed on the use of life science intermediaries (LSIs) particularly to help bridge the divide between industry and academia. Life science intermediaries come in different guises and include a range of different organisation types. Our 3 cases will include an Open Innovation Bio-incubator located in close proximity to a pharmaceutical company, the second will look at the role of Research and Innovation Campuses and the final case is a high performing international Cluster Network Organisation. This session will discuss how these 3 different case studies of life science intermediaries are successfully meeting the challenges to drive the commercialization process and have become the unsung heroes within the sector.

Methodology:

The panel moderator will present a short overview of the life science intermediary space, explaining what constitutes these unique entities and why they have become such a valuable asset in the war in bridging the innovation divide. The first panellist will present on how the pharmaceutical sector is experimenting with life science intermediaries and what they can gain from this. GSK has invested in an Open Innovation bio-incubator that they helped build in a Triple Helix partnership on one of their R&D sites. The second panellist will explain the role of a Research and Innovation Campus and what competitive advantage this model brings to companies located there. The final panellist will explain how they address market needs. By identifying, targeting and investing in areas that stimulate commercial growth, by harnessing the academic excellence in the region. These 3 speakers will be introduced by the moderator before they speak and there will be an opportunity for Q&A to the panel

Speaker 1

Malcolm Skingle CBE, DSc, PhD, Director, Academic Liaison, GlaxoSmithKline, UK

Speaker 2

Celia Caulcott, PhD Executive Director Innovation and Skills, Biotechnology and Biological Sciences Research Council

Speaker 3

Florence Agostino-Etchetto, General Manager, Lyonbiopole

Moderator

Deborah Spencer, Senior Innovation Manager/Doctoral Researcher, Dundee Business School, University of Abertay, Dundee

Table 18: Audience Questions at Bio2015 in Philadelphia

Why is it appropriate for Government to invest in space for companies?
Do you work in an intermediary?
What type of Life science Intermediary do you work in?
Why does having knowledge exchange and commercialisation activities an important tool for Bio-incubators and science parks?
Are partnerships between companies (SMBs, industrials…) and Research Centres a good way to develop innovation in Life Sciences?
What would your region look like if it did not have a Cluster Network Organization?
Which of these Life Science Intermediaries do you believe are heroes?
Do you think that it is appropriate that government funding is used to underpin what, at the end of the day, will result in several commercial concerns?
What makes you believe that an academic start-up will do better at an incubator that is anchored close to a major pharma site rather than being next or, or part of, a university?
What makes you optimistic that the SBC will be a success and which metrics will you use to demonstrate this success?

In summary, the audience only half-heartedly took part in raising their hands to these questions. The idea with that the electronic data capture would have been done anonymously and therefore no one wanted to really participate and for everyone to see how they were answering. It was a sad conclusion to months of preparation.

5.8.6 *The PraxisUnico Conference 10 -12 June 2015, Dublin*

5.8.6.1 *Synopsis of key points from field notes from Incubation session*

1. A discussion on why intermediaries struggle to engage with universities
    a. Competition
    b. Lack of opportunities
    c. Small teams
2. Academics are not team players they are individual researchers. They want money to do more research
3. The speaker had worked with some academics and described them as sneak-outs as they were circumventing the TTOs.
4. We put entrepreneurship first with an exciting accelerator programme
    i. We put students into teams
    ii. Then build on ideas and opportunities
    iii. Push and validate the process
    iv. With customers by 12 months period

The example given here was very similar to a programme created in Stanford University in California called BioDesign. This is where a multi-disciplinary group of individuals come together as a team to solve specific medical healthcare problems. They are given funding to work on the solution for 12 months and hopefully end up with a solution in the form of a prototype that is ready for market testing.

These initiatives will impact on Case 5 LSIs. A recent paper by (Stumpf, Sandstrom Swanger 2016) claims that there is evidence that shows that the initiatives from within the TTO are highly unlikely to generate innovations and any real economic growth. They go on to say that "*We find that academic entrepreneurship initiatives are characterized by conflicting goals, weak incentive structures for universities and academics, and are contextually dependent upon factors such as university strength."* (Stumpf, Sandstrom and Swanger 2016, p.1)

This feeds into the focus code category on 'Assessing how realistic commercialisation targets are'. This PhD research study found that this particular element was difficult for TTOs to achieve targets set for commercialisation.

5.9 Conclusion of Chapter:

The thrust of this chapter was to present the data and analysis. In addition an explanation of the process of coding used within the analysis was provided and then the categories required to review the data under the initial codes was given. This required the laborious matching of all the transcribed data against first the initial codes and then the focused codes. This was the same for the secondary data and for the memos.

The focused codes were derived from an intensive exercise of scrutinising the initial coding data once it had been applied to all the transcribed data. Focused codes using gerunds were determined, and were sometimes either a combination of more than one initial code or taken directly from the eight categories of the initial codes.

Once the focus codes were applied to the data including: primary, secondary and the memos, the researcher was able to construct the theoretical concepts. The theoretical concepts will be discussed in the next chapter as will the comparisons between the five Case LSIs.

The structure of this chapter allowed for discussion to take place at the same time as the analysis, however, there will be further discussions in the next chapter that will link to many of the discussions started in this chapter.

Chapter 6 Discussion

6.1 Introduction

Chapter 6 will add to the discussions within the analysis chapter and will include some further explanations on processes leading to the emergence of theory or theoretical concepts.

A key part of this research has been to compare the LSI models in order to determine the model LSI that would be best suited to delivering KEC. This is outlined within this chapter along with a comprehensive evaluation of the research quality applied along the way.

6.2 Forms of Telling

On analysis of the data, the researcher discovered that the interview data revealed some quite interesting results similar to the Forms of Telling that Charmaz had encountered in her own research and had recounted in her 2014 book. Her study involved investigating patients experiences in hospital and she found that people invoked different forms of telling, which led her to look more closely at why, how and when her participants changed their earlier forms of telling or recounting of their experiences. She noted that the subjective stake in telling exceeded the researcher's ability "*to plot along a simple continuum"* (Charmaz 2014, p.149).

On closer inspection of the data, the researcher discovered that there were clear similarities to what Charmaz had found in her research and had called Forms of Telling. This discovery was made on carrying out the analysis at the initial coding stage and before the data was applied to the focused codes. One of the eight categories from the initial codes, The Life Cycle of the Project/Funding (Table 15), was included in The Funding Life Cycle (Figure 13) which illustrated the forms of telling.

This particular category, on closer and deeper analysis revealed some links to Forms of Telling, and have links to the why, when and how a LSI is deemed successful. Understanding this has been beneficial to understanding the motivations for telling.

The researcher had expected to find that participants were guarded in what they were relaying to her. What was found was that the life cycle of funding for the LSI, and the subcategories identified, have been linked to the participant's ability to speak either openly or guardedly. They spoke openly when the life cycle of the LSI was already ended or close to ending and cautiously when the LSI was still in operation or had just started and were basically reciting the corporate line.

What was unexpected was the openness that appeared when the LSI had already closed down or when the funding was close to the end. The researcher was interested to note that this was something that Charmaz (2014) had also come across in the course of interviewing participants and had not expected. This led to her reviewing the different forms of telling. The main difference here is that the participants have recounted more strategic information than biographical information from their patient experiences, with Charmaz's participants. What is apparent that the participants from this study were passionate in the telling, with the hope that by conveying this information they will make a difference to future strategy. Examining this section of the research into forms of telling made the researcher look at how this could relate to answering the research questions. One of the four main research questions is

> RQ2. What are the key perceptions and expectations of the KEC value that LSIs hold?

Thinking about the life cycle of the LSI is in fact useful in the context of better understanding the motivations and conditions at play that have allowed the researcher to glimpse these few unexpected revelations.

The following is a couple of excerpts from the initial coding category of the life cycle of the LSI. The memo made at the time of the transcription of the interview has been included.

> *1h: I actually feel that [redacted] are blockers in this process, in that the public sector has an overbearing influence. Here … with account management of the companies.*

> *MEMO- Not many people would be willing to say this about [redacted] this organisation.*

1h spoke passionately about something he felt was a major barrier to success of the LSI. This LSI is due to close in 2017, so the participant wanted to pass on the experiential knowledge gained and felt unencumbered enough to be critical of their stakeholders.

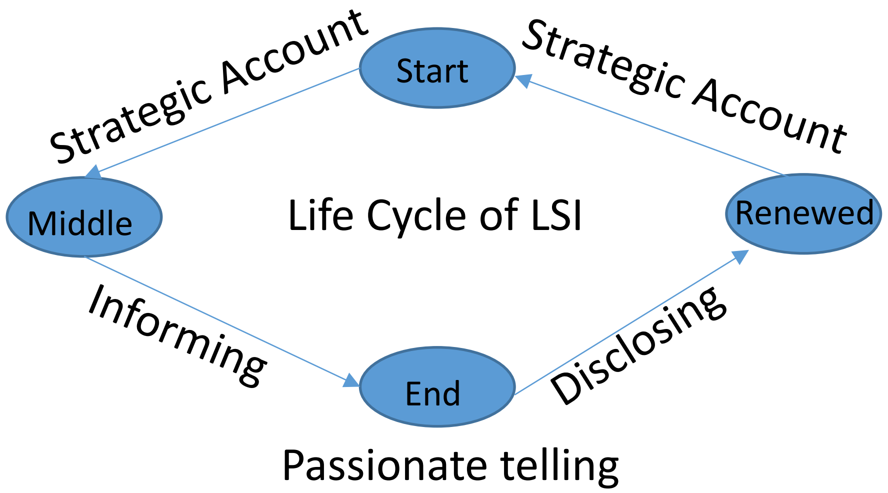
> *1g: Everyone knows that patents are worthless without the scientists to explore them. The Government is focused on job creation, but should actually be focussed on IP that is sticking to the country. And of course Biotech is very good at producing IP driven businesses. The 3rd thing is infrastructure and bottle necks, delivering money will not get these solved. Gigabytes is really important, super broadband infrastructure technology is needed and Superfast trains, cross rail we need these things.*

1g spoke passionately about the barriers as he sees them. His LSI is in the middle of the life cycle, his delivery was passionate and informative. The researcher interpreted this as an identification of where the gaps were from someone on the ground. There is an element of passionate disclosure given by both these participants that are linked to the stage of their intermediary's life cycle.

Reviewing the data once all the case models were coded, only one LSIs from Case 5 LSIs were not impacted by the life cycle of the LSI. In hindsight these TTO LSIs from Case 5 are not funded in the same way as the other case LSIs and do not have the same issues relating to funding cycles as the others do. They tend to be embedded within the Universities core administrative functions even when some of them are subsidiary companies like ERI in Edinburgh which became a limited company in 1998.

The link with this category to the research question elements of perception and expectation is clear, it provides depth to the analytical process. A diagrammatic representation (Figure 11) shows how the different stages of the life cycle of an LSI links to the different forms of telling.

Figure 11: The Life Cycle of an LSI



Life cycle stages of a LSI that links to forms of telling. Adapted from Constructing Grounded Theory (Charmaz 2014, p.149)

At the start of the life of a LSI, strategic accounting is the form of telling employed by the participants. During the middle of the life cycle the form of telling is more of informing and trying to get across more information as the LSI is heading towards an end point. The delivery at this stage can be a passionate telling. When the participant is talking about an LSI that has ended or closed down or is very near to being at that stage the telling becomes disclosing, as in disclosing information and thoughts in a passionate way. If the life of the LSI is renewed, like in the case of One Nucleus then the form of telling again becomes strategic accounting. There is a hint of passionate telling, especially when discussing how the LSI evolved into its currently revitalised form.

Figure 12: The Stages of Telling as Applied to the 22 LSIs

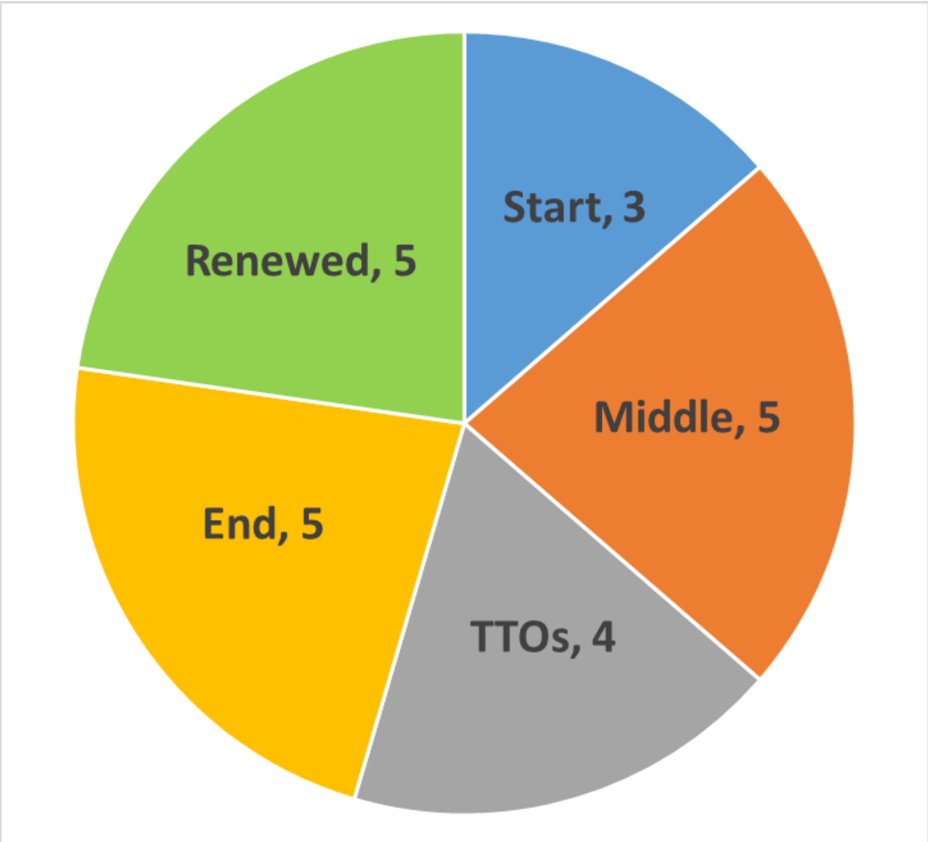


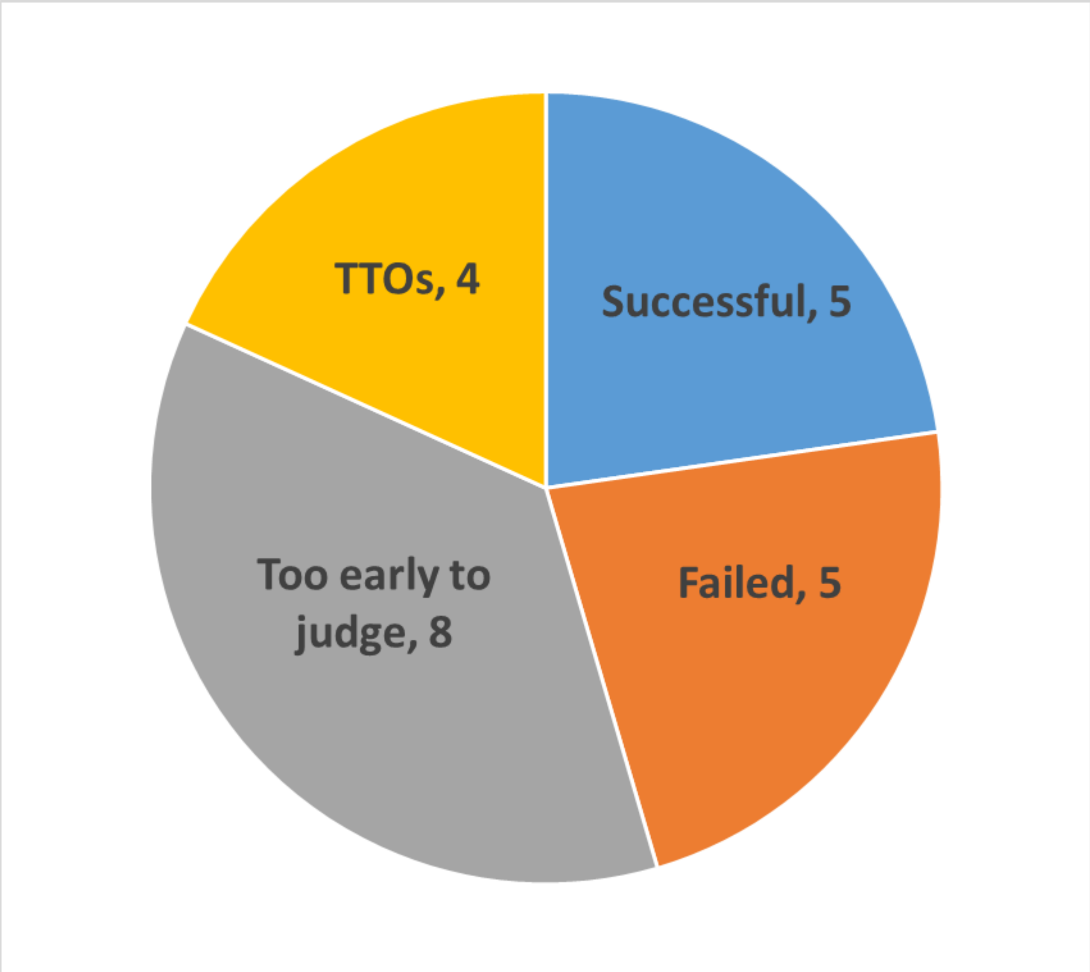
Figure 12 above shows where the 22 individual LSIs fall within the different stages of telling. For both the Start and Renewed criteria, the LSI participants recited the corporate line. For those in the Middle criteria the participant was much more informing and for those that had ended or were near the end they passionately disclosed information.

This analysis led the researcher reflecting further on what success and failure meant for LSIs. In the literature review on the past LSIs the researcher assumed that the closure of these LSIs, either because the funding had been stopped by the stakeholders or the funding period had ended, represented failure.

It should be noted here that the TTOs have not been added to the Middle criteria because they receive their funding in a different way from the Universities they are linked to.

Below in Figure 13 the researcher has assigned each of the 22 LSIs to one of the 3 criteria on the funding Life cycle in relation to whether the LSI falls in: Successful (at the middle of its funding life cycle); Failed (near the end or at the end of its funding life cycle) and Too early to Judge (at the start of a new or renewed funding life cycle).

Figure 13: The Funding Life Cycle in Relation to Success and Failure of the 22 LSIs



The TTOs again are separated as they receive funding in a different way to the other LSIs.

The researcher understands that this distinction is still somewhat subjective and is based upon assumptions made by the researcher on the data analysed. The "Successful" category is represented by those in the Middle criteria of their funding life cycle. However these may still fail. This success is therefore assumed. The criteria for "Failing" is an LSI whose funding has been stopped or whose funding has come to an end, but is this a good enough definition of failure?

The researcher would argue, based on the literature reviewed on the German Fraunhofer Centres and the UK Catapult programme discussed previously, that longevity has a part to play in defining success and failure of the LSIs.

6.3 Comparing the 5 Case LSIs

The process of constant comparison has allowed the researcher to review the LSIs that perform best in carrying out KEC. As discussed previously the 5 Case LSI models varied, as did the individual LSIs themselves. When it came to Case 3 LSIs the researcher came to a hurdle: should these LSIs be distributed to the other four Case LSIs or keep it as a Case in its own right. One of the discoveries here was that the Case 3 model LSIs should not be a standalone Case model. The researcher decided to keep it as it had originally been set out. Conducting a ConGTM means that by delving into the data you make discoveries (Charmaz 2014). Then there was the promotion of the research and innovation campuses by the Research Councils. The observational data collected (see the Innovate UK conference data in the Chapter 5) on this was very compelling, hence the decision to keep them as they were.

Most of the LSIs were there to support and help young companies grow. This means you need to arrive at the LSI with the idea for a company or an already established one. Only the Sector Specific Thematic LSIs (case 4 LSIs) had funding, resources and targets geared towards commercialisation or in other words creating new entities like spin-out companies. These Case 4 LSIs believed their LSI model worked best as all their staff had experience of working in industry and as one participant from these LSIs said they considered themselves “industrialists”.

Each of the 5 Case LSIs were reviewed and compared under the headings of each of the focus codes, then put into a simple table to show how the researcher has graded each of the Case LSI models.

Table 19: Comparison of the Case LSIs using Focused Codes

Focused Codes	Case 1 LSIs Science Park & Incubators	Case 2 LSIs Cluster Network Organisations	Case 3 LSIs Research Institutes and Innovation Campuses	Case 4 LSIs Sector Specific Thematic Intermediaries	Case 5 LSIs Technology Transfer Offices
Bridging the divide between academia and industry	2	1	2	3	3
Recognising the power behind a brand	1	1	2	3	5
Understanding the factors needed for success	3	4	2	1	4
Understanding the expectations of stakeholders	2	2	1	1	2
Assessing how realistic commercialisation targets are	3	4	3	1	4
Totals	11	12	10	9	18

The scale:

- 1 = High to 5 = Low
- A low score = Best overall performance
- A high score = Worst overall performance

Table 19 clearly shows that not one single Case LSI model stands out above the others, although one Case LSI model has scored a total of 18 points in total, which is much higher than the other four, this reflects the worse performing LSI in this research study. They appear to all have some areas where their performances are very good and others that are poor. The lowest score was 9 and that was Case 4 LSIs the Sector Specific Thematic Networks (Table 19). These LSIs were able to function best in creating value in KEC activities. The stakeholders had set targets and provided resources so that the LSI could achieve its goals. Case 3 LSIs followed with a score of 10, again these LSIs were given targets and resources to enable their KEC activities. Cases 1 and 2 LSIs score 11 and 12 respectively. Having completed the analysis it was clear that these LSI models say they provide KEC activities, however, the reality is that it is really KE and very little C or none at all that are supported, in particular Case 2 LSIs.

A recent study by Brown, Gregson and Mason (2016) claim that entrepreneurial spillovers from universities have been overstated and that there is evidence that expectations from universities for commercialisation activities have just not materialised. The results from this research support this claim. Stakeholders from policy-makers and economic development departments have high expectations from university TTOs to generate entrepreneurial or commercialisation outcomes that are being questioned (Brown, Gregson and Mason 2016). From Table 19 we can see that Case 5 LSIs scored 18 points which is 6 points higher than the second highest scoring LSI model. A HEFCE report (September 2016) presented a framework for KE and good practise in TTOs. The report explored why universities were doing KE and compared them to how well they did against other countries. The conclusion was that this LSI model would always be subject to '*vigorous debate'* (Higher Education Funding Council for England 2016). Expectations and outcomes varied in the different regions of the UK, with peripheral regions performing worst.

6.4 What constitutes a high-performing LSI?

There are a number of elements that need to be considered when creating a new LSI, one of the important ones to come through from the data, is branding. LSI 2b has had a 17 year history and have continued based on the strength of their brand both nationally and internationally, despite fluctuations in their funding. Successful brands can be created and with investment like some of the new LSIs like 2a, 3c and 4g, who are well funded and have the resources to ensure targets for KEC are met, they can invest in activities to strengthen their brands.

6.4.1 *Reviewing the KE and C*

On examination of the data, can we decide on which LSI model is stronger at performing the KEC function? The answer is quite straightforward, the LSIs who have been given KEC targets at the onset are in a stronger position as they have this function built-in to their processes. Many of the older LSIs particularly those in Case 2 LSIs, the Cluster Network Organisations are designed for KE but not for the C – commercialisation element. Commercialisation is defined in a different way in each of the 5 Case LSI models.

Table 20: The Different Forms of Commercialisation Employed by the LSIs

	LSI Model	Commercialisation
Case 1 LSIs	Science Parks and Incubators	Growing sustainable companies and inward Investment
Case 2 LSIs	The Cluster Network Organisations	Growing sustainable companies and inward Investment
Case 3 LSIs	The Research Institutes and Innovation Centres	Spinning-out new companies and proof of concept
Case 4 LSIs	The Sector Specific Thematic Intermediaries	Spinning-out new companies and proof of concept
Case 5 LSIs	The Technology Transfer Offices	Commercialising research through licensing, Patents and spin-outs

Table 20: The Different Forms of Commercialisation Employed by the LSIs above helps us review the different model of commercialisation that are used by the 5 different Case LSI models. We can see that Case 1 and 2 LSIs have a requirement to grow and develop companies and to attract inward invest into their LSI and region. Case 3 and 4 LSI models both have a remit to spin-out companies and to help move innovations out of the research base through proof of concept funding. Case 5 LSIs do have an expectation for spinning-out companies as well as commercial gains through licensing and patenting activities. They are expected to cover a full range of commercialisation activities, which could be why they are considered less efficient at the KEC element.

Having unrealistic targets on commercialisation will set up the LSI for failure and it will join the other LSIs who have come and gone like some of those discussed in Chapter 3 like the Faraday Partnerships and the Intermediary Technology Institutes. This leads us into the discussion in the next section on stakeholder expectations.

6.4.2 *Reviewing Stakeholder Expectations*

The expectations from stakeholders is another area where LSIs have had to overcome issues. The analysis showed us that even in the high performing LSI models, like Case 4 LSIs, there were still barriers to overcome. One of the Case 4 LSIs was given very high commercialisation targets that needed to be negotiated by the management team to something that could be realistically achieved. This has led to the simple formula being created.

Stakeholder Perception – reality = Expectation Gap

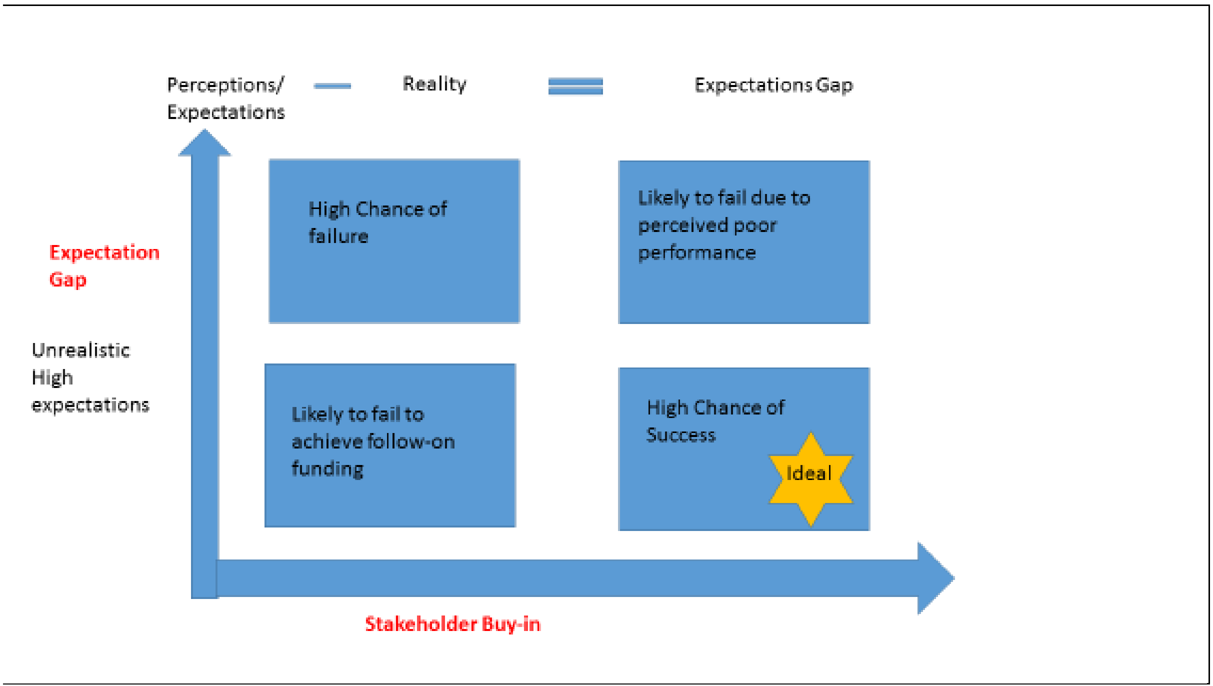
Many of the stakeholders for each of the LSIs have contributed to the expectation gap. This has sometimes been done simply through a perception that the LSI can provide more than it was created to do.

Some of the unrealistic expectations that have been seen in this PhD study include 2 LSIs Nexxus and Scottish Stem Cell Network where the funders and government stakeholders had the expectation that the LSI would become self-financed at the end of the funding period. Despite a valiant effort by the LSIs to achieve this, it did not happen and the LSIs were shut down and, as we noted in the previous section, this corresponds to the perception of failure.

In Figure 14 we can see the LSIs that fall in the left hand boxes will have a high failure rate caused by them either failing to achieve the set targets (which were probably unrealistic or unachievable) or by them not becoming self-financed. We have seen that both Nexxus and the Scottish Stem Cell Network failed to receive follow-on funding in order to continue.

The box on the top right side of the diagram (Figure 14) shows us that a company can still fail even if the stakeholder buy-in was high, but the expectations were still high. The ideal place to be for LSIs is in the bottom right hand box where the stakeholder buy-in is high and expectations are also realistic. The expectation gap will be reduced to zero here. This is an important message for policy-makers, funders and government bodies who create these LSIs, however, it is also important that LSIs better understand the realities of these perceptions and subsequent expectations and that they manage these expectations from the start of the life cycle of the LSI.

Figure 14. The Expectation Gap



This diagram illustrates the perceived expectations of the LSI in relation to the realistic expectation and stakeholder buy-in.

(Source: This research)

6.4.3 *Reviewing other Barriers to Success*

Most of the LSIs encountered barriers to their success which they have to overcome. One observation made of a number of the new LSI models is that there is a particular focus on recruiting employees from industry. These particular recruits experience difficulties in engagement with the academic sector. It is nothing new to hear about the cultural differences and the differences in working between the two sectors, and it is clear that this will not change. In addition, the barrier of not having insights or specific academic contacts can also make it difficult to engage with academia, which is a primary function of LSIs.

Comparing the Case LSIs has assisted in helping to understand and construct the theoretical concepts that are discussed later in this chapter.

6.5 Theory Development

Charmaz (2014) asks the researcher in constructivist GT to consider their own understanding of what theory is before presenting the emergent theory from interpreting the data. Thornberg and Charmaz in their 2014 paper provided a simplistic definition of what they see as theory:

> *"A theory states relationships between abstract concepts and may aim for either explanation or understanding." (Thornberg and Charmaz 2014, p.41)*

In a positivist study the researcher views theoretical concepts as variables and then the focus is on the observable evidence (Charmaz and Belgrave 2013). This research is based in the realm of the interpretivist and the theoretical concepts that have been developed come from this philosophical perspective. Therefore, with the interpretive approach the researcher interprets the participant's meanings and actions and understands that the participant would have in turn interpreted the researcher's meanings and actions.

> *"Knowledge and theories are situated and located in particular positions, perspectives and experiences.*
>
> *Interpretive theory calls for the imaginative understanding of the studied phenomena. This type of theory assumes emergent, multiple realities; indeterminacy; facts and values as linked; truth as provisional; and social life as processual." (Charmaz 2014, p.231)*

First, the researcher collated all the disparate parts of the collected data, including:

- Primary interview transcription data
- Secondary Data
    - Websites
    - Reports and Documents
    - Events (conferences, meetings and workshops)
    - Observations and memos

Then, applying all the data to the first set of coding the initial codes, the focused codes emerged and the data was then applied to these codes. The final part was in reconstructing the data using this information and the researcher's own understanding of the substantive area - incorporating her own assumptions and interpretation of the results to construct the emergent theory. This led to the development of the theoretical concepts.

6.6 Emergence of Theoretical Concepts

Five theoretical concepts have emerged from the above analysis, each has been identified as the theoretical saturation of the data was reached and the categories emerged, and was constructed to form these theoretical concepts. Charmaz (2014) says to *"Offer an imaginative theoretical interpretation that makes sense of the studies phenomena" (Charmaz 2014, p.231)*

1 *LSIs who are given specific KEC targets from the onset are more effective and therefore are perceived to be of greater value in the KEC opportunities.*

It was clear from the data that LSIs who were provided with specific targets were able to focus on achieving these through their KEC activities.

2 *LSIs who are created to provide opportunities for tacit KE only, have less chance of continuing beyond the funding period.*

The majority of the funding for many LSIs is from public funds and return on this investment is governed by economic drivers, like company creation, employee numbers and inward-investment. The two options for these LSIs are to find new funding with different partners, become a self-financing membership organisation or accept the end of the LSI.

3 *LSIs who employ staff from both sectors have a greater ability to understand working practices and cultural differences, which will enhance the bridging function of the LSI.*

Most of the LSIs work at the interface between industry and academia and need to bridge the divide. One suggestion for a more effective LSI is to recruit an equal mix of employees from both sectors. This would provide a better understanding of the academic drivers and allow the LSI to work more effectively with the academic community. Academics appear to be highly suspicious of industry in general. It would be seen to be a good thing to have a few academic insiders working within the LSI. If anything, the LSIs are seen as a source of funding to the academic community and are reluctant to work with them for fear and suspicion leakage of IP; this suspicion was seen by the previous interactions between the two sectors in some of the now defunct LSIs. For example, the Intermediary Technology Institutes (ITIs) that were based in Scotland – where the issue of IP ownership came between the two sectors (Brown, Gregson and Mason 2016). This led to poor engagement between the LSI and the academic community generally that has been associated to the demise of the ITI LSI.

The current focus is to employ staff from industry, as the perception is that they will understand industry drivers. Getting staff from both sides will provide an equilibrium within the LSI and go some distance in changing perceptions of the LSI from both sectors.

4 *LSIs who are provided with realistic and sufficient resources will achieve their targets and meet stakeholder expectations.*

After the completion of the literature review it was clear that the expectation gap was going to be an important feature of this research. The resulting analysis has shown that many of the LSIs are insufficiently resourced to be able to achieve the commercial, social and economic outcomes that are expected, despite in many cases a worthy effort. One of the LSIs interviewed provided details of how they had to justify to their funders the much lower targets they believed they could achieve during the funding period.

5 *LSIs need to be provided with sufficient timescales in order to make an impact and to help change the innovation landscape.*

The changing political landscape and the pressures of short termism on LSIs was seen in the literature and linked to the failures of many past LSIs. The most notable observation from the data that led to this theoretical concept was the pleading nature of a leading academic to continue with the programme for the UK Catapults programme during a conference in 2014 (Chapter 5, section 5.8.4). However, it is not quite that simple. In order to gain further funding for the LSI, the funders will need to determine how successful the LSI has been and if it has realised all agreed targets. Therefore yes, time should be factored in, but there needs to be justification for further funding of the LSI.

Figure 15 is a diagrammatic representation of the five theoretical concepts that provides a visual that shows clearly the important factors required to ensure a high value LSI and one where KEC is fully embedded.

The five theoretical concepts derived from the data are:

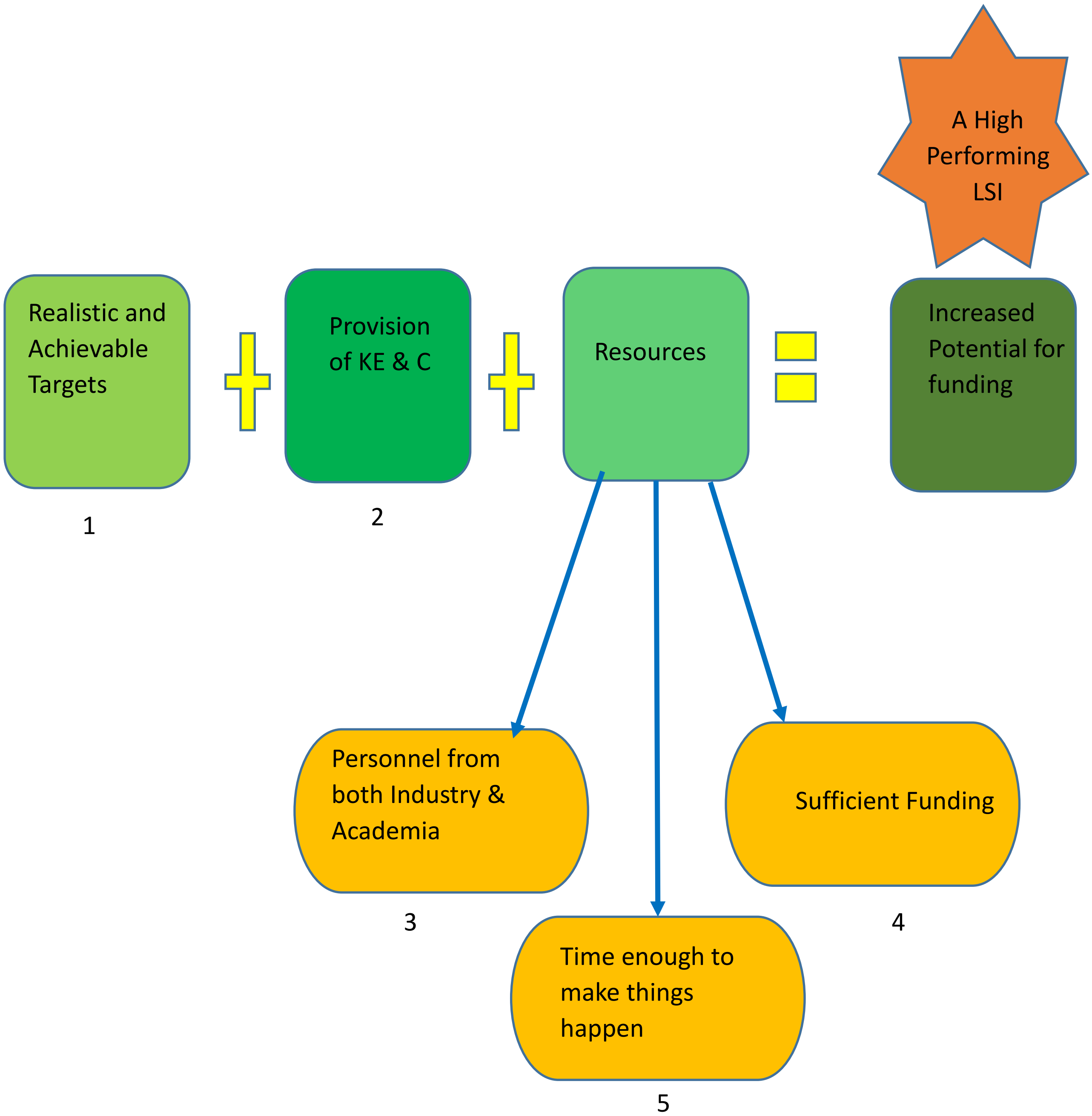
1. *LSIs given specific KEC targets from the outset are more effective and are therefore perceived to be of greater value.*
2. *LSIs created to provide opportunities for tacit KE only, have less chance of continuing beyond the funding period.*
3. *LSIs that employ staff from both sectors have a greater ability to understand working practices and cultural differences, which will enhance the bridging function of the LSI.*

4 *LSIs that are provided with realistic and sufficient resources will achieve the targets and meet stakeholder expectations.*

5 *LSIs need to be provided with sufficient timescales in order to make an impact to help change the innovation landscape.*

A simple framework has been created to show how the variables that have emerged from the data can impact on the KEC of a LSI and the subsequent performance of the LSI

Figure 15. Theoretical Framework Model



6.6.1 *Preconceptions and their Impact*

There has been criticism of theorizing in GT (Dey 1999, 2004, Layder 1998, Glaser 1992, 2002, 2003, Burrawoy 1991). The challenges from these academics are varied and include the assumption of preconception, procedural application and theory based on pure induction. Burrawoy (1991) says this methodology produces generalisations, and argues in favour of Case Study methodology as he says it uncovers the specifics from a situation. Bryant and Charmaz (2010) counter this by saying that

"*GT resides in its applicability across substantive areas*." (Bryant and Charmaz 2010, p.133).

A deep familiarity with the research phenomenon and the application of constant comparative methods as a core feature, allows for the emergence of theory. It should be noted that these theories are mere suggestions and it is for this reason that the researcher has chosen to call them Theoretical Concepts as they are not the final theory (Remenyi 2013, Charmaz 2014).

Remenyi (2013) talks about the fit and grab of theory. He explains that fit means that the theory adequately describes the data that is linked to it. In an explanation of grab, he says that if the theories suggested are used in the real world by practitioners, then this goes someway in validating these research findings. Acknowledging the fact that Constructivist theorist must consider their beliefs and how they affect the research is an important factor in conducting Constructivist GTM.

> *"Engaging in reflexivity about preconceptions and holds special significance in focused coding because these codes shape our analyses"* (Charmaz 2014, p.155).

Throughout this research process and particularly during the interviewing and analysis of the data, the researcher was keenly aware of her own interpretations and those of the interview participants. This reflexive approach has been an important feature towards undertaking this PhD research study and one that would be viewed as being of high value and high quality by the researcher and hopefully the reader.

6.7 Evaluating the Research Quality

The quality of the research has been an important theme throughout this research study. This is the stage, according to Charmaz (2014), where the researcher should look back at the research process and forward to envision what the final product will look like to the various audiences. Evaluating the research quality is basically an audit of the research and Charmaz in her more recent book published in 2014 has outlined specifically the criteria to examine the research process under the following four headings. Each criteria will be explored using the specific questions as outlined by Charmaz (2014, pp.337-338) and discussed under each of the following headings:

6.7.1 *Credibility*

Q. Has your research achieved intimate familiarity with the setting or topic?

A. The research is focused on elucidating the value from the activities and the organisational processes of the 5 different LSI models. This focus throughout the research has been a familiar theme from the onset.

Q. Are the data sufficient to merit your claims? Consider the range, number, and depth of observation contained in the data?

A. Although some of the LSIs have larger numbers of individual LSI – for example Case 1 LSIs, the incubators and sciences parks – there was a sufficient number of quality participants. This is the case for nearly all case LSIs – apart from Case 3 LSIs which had only 2 different LSIs. Although the observational data in this case provided a little more clarity on some of the expectations relating to KEC from the Research Councils that fund these LSIs as strategic campuses, it became clear at the analysis stage that these Case 3 LSIs should be considered Case 4 LSIs rather than a standalone Case model.

Q. Have you made systematic comparisons between observations and between categories?

A. The researcher, by using constant comparative methods and field notes/memoing throughout the research process, was able to compare the data from the observations and relate them to the categories identified. These comparisons helped to reinforce the analysis by interpreting the data.

Q. Do the categories cover a wide range of empirical observations?

A. The categories identified for the initial codes were wider ranging, which allowed for a more in-depth review of each Case LSI and in-turn each LSI within the case model itself. The focused codes were then identified. These had five main categories, which represent an amalgamation of sometimes more than one of the initial coding categories. Whether there should have been more categories is hard to say, the researcher spent time immersed in the coding in order to ensure that the categories chosen would be focused on answering the research questions and would be beneficial to practitioner’s and other researchers.

The ConGT process itself has built-in processes to allow for the exploration into past, present and future (Charmaz 2014). This in itself allows for wide ranging empirical interpretations. The researcher used the methods to seek out knowledge on the sector and on the LSI participants interviewed. The observational data included reports written, newspaper articles, newsletters and various network websites. For the events and conferences attended the researcher made field notes and memos on all pertinent information that may have impacted on the research during the data collection process. This level of rich data, hopefully validates the number and quality of the categories that were identified.

Q. Are there strong logical links between the gathered data and your argument and analysis?

A. The researcher has been fortunate to have been able to gather such a large amount of primary data from participants who are the leaders of their LSIs. The ability within ConGT for interpretative analysis, which includes the understanding the researcher has with the participant's sector, allows for there to be strong ties between the data gathered and the argument.

Q. Has your research provided enough evidence for your claims to allow the reader to form an independent assessment – and agree with your claims?

A. The reader will hopefully be able to follow the logic of the arguments and assessments as the justification for statements have been made using data from the transcripts of the interviews themselves. As Charmaz has said each reader will interpret the data differently based of their own understanding of the sector that the research is located.

With ConGT it is accepted that the research will be revised.

" Not only does a Constructivist approach help you to remain clear about the antecedents of your constructed theory, this approach helps other researchers and policy-makers to establish the boundaries of the usefulness of your grounded theory and possibility to ascertain how and where to modify it." (Charmaz 2014, p.339)

6.7.2 Originality

Q. Are your categories fresh? Do they offer new insights?

A. The five LSI Case models that have been used in this research have been studied by other researchers on an individual basis. To the researcher's knowledge there has not been any research study that evaluates and compares all five against their ability to add value to the KEC processes within their organisations. This in itself has presented new insights and will hopefully prove useful in particular to funders of LSIs considering the role and function of these LSIs and what to expect from them given the resources provided.

Q. Does your analysis provide a new conceptual rendering of the data?

A. We are in the age of evidence-based research and it is hoped that this research study will add value to those looking to support new and improved LSIs. One of the focused codes was to explore what the factors were for success. It included a number of different categories from the initial coding process, which included branding, barriers and the life cycle of the LSI. This system of coding and analysis within the ConGT methodology did as was predicted by Charmaz and revealed concepts previously unthought-of . This type of data has never had ConGTM applied to it and it is hoped that the readers will understand the originality of the interpretive process as applied.

Q. What is the social and theoretical significance of this work?

A. Many of the LSIs receive funding from Government, which means it is tax payer's money. We have a moral duty to invest in initiatives that will benefit society and help to improve our economy. The LSIs are funded as a way to help create new enterprises to ensure our innovations make it out of the universities and can encourage wealth generation. The theoretical significance is to provide concepts that will help policy makers make the right decisions. Research, if deemed to be of quality, can have an impact on decision making.

Q. How does your grounded theory challenge, extend, or refine current ideas, concepts, and practises?

A. The importance of reviewing the literature once the analysis is completed is a common occurrence in research studies. This study has been no different. In this fast paced sector things change rapidly, it is important that current ideas are reviewed against the theoretical concepts from this research study.

The key features that this research will bring to current practises includes exploring the expectation gap more thoroughly before policy-makers and practitioners embark on any new proposed LSIs. What is really achievable given the resources including funding and time? Finally those LSI that have a poor record for commercialisation need to find solutions to address the issue, like in some TTOs

6.7.3 *Resonance*

Q. Do the categories portray the fullness of the studies experience?

A. As mentioned previously in this chapter, the analysis of the data was particularly lengthy and could have gone on longer, having more categories would have tipped the research over the approved time limits. The categories and codes used within the study provide a balanced portrait of the studies experience.

Q. Have you revealed both liminal and unstable taken-for-granted meanings?

A. This has all been part of the interpretative nature of the study. Much of the unbalanced or unstable meanings have been explained in full to help the reader understand the reasoning behind an argument.

Q. Have you drawn links between larger collectivities or institutions and individual lives, when the data so indicate?

A. This question probably does not apply here, as the majority of the research studies that Charmaz was involved in have been in relationship to nursing or medical support practices and not to business management studies. However, in order to answer this question, the researcher can confirm that the individual or participant was considered in the context of the larger organisation. This chapter discusses the link to the funding life cycle stage of the LSI and its importance. This was described in this chapter under 'Forms of Telling'. With new LSIs there was a more targeted approach to the interview, while those at the end of their funding life cycle, there was more information provided on what could have been done better by the institutions or funders.

Q. Does your grounded theory make sense to your participants or people who share their circumstances? Does your analysis offer them deeper insights about their lives and worlds?

A. Before being granted the time to conduct the interview, the researcher had to contact the participant, all of whom are leaders in their respective LSIs and explain the purpose of the study and what the research hoped to achieve. They would not have agreed to take time out of their busy schedules in order to gain nothing.

In addition, the interviews themselves provided an opportunity for the participants to review their own LSI processes and discuss their aims, their strategies and to review the expectations from a variety of stakeholders. Towards the end of the interview with 4a, the CEO was telling me about plans to create a new manufacturing facility as an extension of their LSI. The researcher who had interviewed participants at LyonBioPole in France was able to inform the CEO of a manufacturing hotel there that the CEO was not aware of. This was an example of the benefit that the participants gained from taking part in this study. For 4a they had ambitions to be the first in Europe to provide this kind of service. If nothing else it compelled them to research this further.

6.7.4 *Usefulness*

Q. Does your analysis offer interpretations that people can use in their everyday worlds?

A. When discussing if knowledge should transform practice and social processes, Charmaz (2014) gives a resounding yes! She says that ConGTM can contribute to a better world. She says that knowledge is not neutral, nor should it be separated from the real world. When embarking on this research project the researcher, who had worked in the sector for 15 years previously, had the ambition to make this research impact on the everyday lives of practitioners within the sector.

Q. Do your analytic categories suggest any generic processes?

A. Yes, because the research is a comparative analysis between the five different LSIs there are codes or categories that repeat in each Case LSI model. This is an important feature for comparing the different LSIs and has been useful in identifying the problems in Case 3 LSIs and the subsequent conclusion that this Case does not warrant a standalone Case model and the LSIs within it should be distributed to Case 4 LSIs.

Q. If so, have you examined these generic processes for tacit implications?

A. The issue of time has prevented a return to speak to participants to validate any of the analysis, this will of course feed into the discussion on future research, discussed in the next chapter.

Q. Can the analysis spark further research in other substantive areas?

A. The subject of further or future research in relation to this research study is discussed in the next chapter.

Q. How does your work contribute to knowledge?

A. The hope is that some of the questions asked are those asked by practitioners, policy-makers and funders, and therefore answering questions relevant to them. The contribution to knowledge is twofold, both to the literature on life science specific intermediaries, of which there is scant literature, and to the contribution to the business management literature by applying the ConGT approach to this qualitative study. Again, the researcher encountered very little research available to business management students to guide them through a ConGT study. Please see the next chapter for a more detailed discussion.

6.8 The Researcher's Reflections

Reviewing the overall data has revealed some interesting and unexpected results. The nature of ConGT methodology is that a closer relationship to data collected is part of the process.

In addition to the emergent theories or the theoretical concepts there are a few additional things that are worth some focus and will help to build a picture of the elements needed in addition to the key ingredients found in the theoretical framework. These include the following:

- Having the right champion for the LSI – individuals with energy and passion who are driven to make a success of their LSI. For example, the Queen Mary Innovation Centre was built at the height of the recession and yet has become hugely successful. The fact that this level 3 incubator is full is an indicator of its success and many of the companies that reside within have grown significantly. At the time of the interview the idea was that the larger companies would move out to science parks elsewhere to allow them to grow effectively. However, in a recent conversation with the LSI, it seems that the companies are reluctant to move out as they have complex equipment and facilities and have requested that the incubator finds a way to keep them there.

  This is a divergence from the traditional progression of companies, as they would normally seek to expand elsewhere. Biocity and the other LSI participants with tenants have Biotech companies that want to remain on the incubator sites. This is worthy of further investigations. Perhaps the complex infrastructure of wet labs, office and cleanrooms is contributing to the lack of movement out of the incubators.

- The next revelation may turn the idea of the exchange of tacit knowledge on its head. A few of the LSIs including BioCity, Queen Mary Innovation Centre and RoCRE at Rothamsted Research, indicated that gathering around the water cooler to spark the exchange of ideas does not happen in reality. This is potentially inconsistent with the idea of having an anchor organisation and the idea of building an innovation hub located close to a research centre of excellence is to allow for this kind of KE to take place.

Perhaps it will work for companies who are still at the very early stages of incubation, but when they get to a certain level, and in particular when they have their own IP, they become a little more guarded about who they speak to and about what.

- The Cluster network organisations over 15 years old were created before social media existed. Newsletters were in hardcopy format and websites were clunky. They were created to largely focus on the KE side of KEC and even though they have survived, mostly as self-financed membership organisations that have no commercialisation targets set, their business model does not sustain the commercialisation aspect of KEC.

  Again further investigation as to whether this would be possible would be of value as the membership of these Cluster Network Organisations has grown substantially over the years. One of the Cluster Network Organisations said that they helped to facilitate commercialisation by those more focussed directly on it, such as the TTOs. Therefore, it could be that this symbiotic relationship would work.
- The final item of interest revealed during the analysis stage was that inward investment activities were a low priority for most of the LSIs interviewed. The impression was that they had to take time out of their busy schedules, and in many cases they had to rally senior academics and CEOs from companies to

take part in visits that invariably resulted in no take up. Many felt such activities were a waste of time.

6.9 Conclusion

Those practitioners who have conducted quality assurance in their work will appreciate the detailed audit that this chapter presented. This will in particular help to reinforce the issues of quality to other researchers and those in particular from the natural sciences, who have a penchant for the reproducibility and the validation of research.

The earlier discussions on Forms of Telling and comparing the 5 Case LSI models brought some insights into the 5 LSI models and allowed for greater comprehension on the specific roles of the LSIs and their provision of KEC.

Theory development was explained from an interpretivist point of view and then the theoretical concepts were discussed and the 5 main theoretical concepts that emerged from the data were explored.

Some of the unexpected responses were discussed under the researcher’s reflections. This provided some further food for thought and will lead on to the final concluding chapter.

Chapter 7 Conclusion of Thesis

7.1 Introduction

This final chapter begins by looking at how the research has contributed to knowledge within the field of innovation intermediaries. We then look at how and if the four research questions have been answered and if the aims and objectives of the research have been met. A deeper discussion follows on how the data links to the literature reviewed. Next, we look at the limitations of the research and the recommendation of future research and how it could be of further benefit to practitioners and policy-makers. The final reflections and concluding remarks are the two final sections of the thesis, here the researcher provides some critical thinking on the study.

7.2 The Research Contribution to Knowledge

Intermediaries are important in brokering KEC between the industrial and academic sectors and much has already been written about different aspects of these intermediaries (Wilson 2012, Hauser 2014, Lopez-Vega and Vanheverbeke 2010). KEC is an essential component within the economic development agenda (HEFCE 2016). This PhD research study aimed to further our understanding of the value that intermediaries bring to the innovation process, and through empirical evidence determine their true value in relation to our investment in them.

In addition, the theoretical framework model based on the five theoretical concepts derived from the coding and analysis aims to help practitioners and policy-makers understand better the key factors needed to create a high-value LSI.

An extensive review of past research has generated evidence of only a few studies using GT in business management or innovation intermediary research. None have been found that use a constructivist GT approach. Most of the innovation intermediary literature has not focused on a single sector (Howells 2006, Suvinen, Kottinen and Nieminen 2010, Lopez-Vega and Vanheverbeke 2010). This study satisfies Suvinen, Kottinen and Nieminen's (2010) call for sector specific innovation intermediaries to be explored. This also covers the call from Lopez-Vegas and Vanheverbeke (2010) to investigate 'yet undiscovered' modes of intermediaries. This research has added LSIs to the literature as discussed in chapter 3 under 'Terminology'. LSIs are a collective name given to intermediaries operating within the life sciences sector.

Swan et al. (2007) had determined that it was important to carry out a comparative analysis, which has been done in this study. This analysis led to the creation of the five theoretical concepts, something Rank, Rank and Wald (2004) proposed in their call for future research when they explored biotechnology networks. They wanted future research to be done where it would be possible to derive in-depth details in order to develop further theories. Others like Gassmann, Daiber and Enkel (2011) were interested in future studies on the innovation process models. The framework model based on the five theoretical concepts from this research achieves this (Figure 15).

Past research has stressed the need for studies to explore the role of stakeholders other than companies (Coeurderoy and Duplat 2008, Lawton-Smith and Bagchi-Sen 2006). This was achieved in this study as the interview data came from the CEOs and managers of the LSIs themselves. Access to the companies the LSIs worked with was limited, and the one that was interviewed did not add anything significant.

This research assessed the expectation gap (or perhaps it should be called the 'reality gap') that comes from having high expectations from the LSI stakeholders compared to what can, in reality, be achieved (Figure 14).

Finally, the differences between LSIs and the brokering roles they carry out was explored in this study, addressing the call from Abbate, Coppolino and Schiavone (2011) to review in more detail the brokering function in the KE process.

Novelty comes from the fact that although much has been written about LSIs, mostly from the single case and non-sector specific perspective, there has been no attempt to try and compare them. Yet policy-makers ask questions about which would be the best intermediary model to facilitate specific actions, without fully understanding their ability to achieve the task set with the resources allocated. There is a paucity of literature using ConGTM in the area of business management, this PhD study followed the ConGTM approach and has therefore added knowledge to the field in this research methodology. The researcher believes that the immersion in the data during the coding process helped identify a number of emergent theoretical concepts that will add to our knowledge of these LSIs and although no substantial theory has emerged, these theoretical concepts are a step closer to new theory development.

> *"Inductive theorising opens up the possibility of novel understanding. And increasingly researchers acknowledge that 1) their observations include how they see and define the observed phenomenon 2) they move between creating inductive categories and making deductions about them and 3) explicitly invoke abductive reasoning." (Charmaz 2014, p.243)*

Five theoretical concepts were developed and presented in chapter 6, these are:

1. *LSIs that are given specific KEC targets from the outset are more effective and therefore are perceived to be of greater value in realising KEC opportunities.*

2. *LSIs that are created to provide opportunities for tacit KE only, have less chance of continuing beyond the funding period.*
3. *LSIs that employ staff from the private and academic sectors have a greater ability to understand working practices and cultural differences, which will enhance the bridging function of the LSI.*
4. *LSIs that are provided with realistic objectives and sufficient resources will achieve their targets and meet stakeholder expectations.*
5. *LSIs must be given sufficient time to make an impact if they are to help change the innovation landscape.*

The five theoretical concepts are fundamental to the framework model (Figure 15), and provide a checklist of factors important in the creation of new LSIs or indeed updating existing LSIs. Importantly, they would go some distance in creating high performing LSIs where KEC is embedded.

The contribution this study has made to new knowledge has been to focus on the substantive area of the life sciences sector by carrying out a study based on the sectoral systems of innovation. The new terminology of LSIs has been added to the literature and hopefully will be taken up and used within the life sciences innovation intermediary organisations and those working with them.

The next key contribution has been the five emergent theoretical concepts that make up the framework for high-performing LSIs. In addition, the data allowed us to identify the different forms of telling that helped to link the funding life cycle to success and failure.

Using a multiple case comparator and focusing the research study within the LS sector the researcher has brought new knowledge to the field of study. The initial question as to why so many of the LSIs fail in the UK has been the main focus. In addition, what constitutes success and failure and the ingredients needed for success have been identified and will allow us to measure future performance.

7.3 Addressing Research Questions & Linking to the Literature

In this section we will review the four main research questions in relation to the data collected and analysed. First we will determine if our objectives have been achieved

7.3.1 *The Research Aims and Objectives*

The research aims and objectives identified in chapter 1 are listed below, they are designed to help focus the research by illuminating the research path to help answer the research questions. These aims and objectives are:

- Investigating the role and function of a range of LS intermediaries within the UK and Europe (Holland and France)
- Exploring the ecosystem that each case LSI is located in with respect to their stakeholders.
- Exploring the perceptions and expectations of LSI stakeholders in respect of targets.
- How are outcomes measured and reported in each case LSI?
- Exploring the potential for commercialisation outputs from KEC, including:
    - e. Spin-outs/ start-ups
    - f. Licensing
    - g. Collaborations
    - h. Inward investments

This list of aims and objectives were factored into the interview process, either being embedded within the questions or as specific questions to the interviewee. All of these aims and objectives were fulfilled by this PhD research study. The study was able to recruit participants from all the countries identified in the first objective. There was some concern that using the data collected from the 2 LSIs in France and 3 in Holland would have been inappropriate since they could not be used for a full and equal comparison with the many UK LSIs. This was largely down to the lack of resources both in time and finances to allow the researcher to recruit equal numbers of LSIs that would be comparable to the numbers recruited in the UK. The solution was to utilise the data from them to support that collected in the UK. Doing this highlighted no differences in national innovation systems: the LSIs in France and Holland have similar NISs that apply to them – for example the patenting system, the system for drug approvals and the innovation ecosystems. LyonBiopole has many more examples of successful Triple Helix partnerships than the UK, this was the only noticeable difference.

This also ties in with the second objective, where the ecosystem of the LSI was taken into account. The last three objectives were built into the research questions and have subsequently fed in to the theoretical framework that resulted from the emergent theoretical concepts.

7.3.2 *The Research Questions*

As discussed in Chapter 1 the first two research questions were identified early in the study, while the other two research questions were identified after a further stage of the literature review process.

The four main research questions this PhD project endeavoured to answer were:

RQ1. Are LSIs important for the commercialisation of research?

RQ2: What are the key perceptions and expectations of the KEC value that LSIs hold?

RQ3. Why do some LSI fail to survive beyond their funding stream?

RQ4. How important is an anchor organisation to an LSI?

7.3.2.1 RQ1. Are LSIs important for the commercialisation of research?

As previously discussed in Chapter 6 when comparing the different LSI models, they varied in the type of support for commercialisation that they offered (see Table 19). If we explored each Case LSI a little further to help clarify and review the importance of the level of commercialisation activity in each LSI. These differences have had an impact in their commercialisation performance.

<u>The Case 1 LSIs</u> are the incubators and science parks. They do not specifically offer commercialisation services to their tenants, they can offer KE and a range of services that help an SME to grow and develop – all valuable services. Although this appears to be changing as incubators, like BioCity, and Science Parks, like the Pentlands Science Park, have engaged commercialisation business development managers. This could be a new trend, as the Business Development Managers work with the tenants to look for funding for them to grow, thereby adding value. Therefore it is not just about creating new spin-out companies, it is also about company growth. Most of the Case 1 LSIs are focused on filling their incubators and sciences parks. They are therefore interested in the inward locating companies rather than specifically themselves spinning-out companies. If they are located near to an anchor organisation such as a university or research institute they would welcome any spin-outs from these organisations.

<u>The Case 2 LSIs</u> are the cluster network organisations, and again like the Case 1 LSIs they do not generally offer support for commercialisation activities. Their main

focus is in the KE and connecting companies to customers and to research collaborators.

The Case 3 LSIs that were interviewed had clear commercialisation targets set by their funding stakeholders. Commercialisation activities for these LSIs include helping to grow the companies already located on site and attracting new inward locating companies. Their main objective, however, is to commercialise new innovations coming out of the research based at the nearby research institutes and universities. The LSIs interviewed in this Case LSI model included both Rothamsted and BioAster who were fairly new LSIs therefore both had specific targets for KEC from the onset. As mentioned previously these Case 3 LSIs should both be placed within Case 4 LSIs.

The Case 4 LSIs are the sector specific thematic intermediaries. These LSIs are expected to have KEC embedded within them. The Case 4 LSIs do have commercialisation within the heart of their main function. The evidence provided by Edinburgh BioQuarter shows that without their LSI very little in the way of new innovations and new spin-outs were making it out of the University they work with. This LSI had a high success rate in creating new spin-outs. The metric by which they were measured was the number of spin-outs over a period of time, however they also had a programme of KE events that they disseminated to the sector. When reflecting on the university's previous history of low commercialisation outputs, it does appear to validate RQ1 and in the case of the most recently created Case 4 LSIs like the Edinburgh BioQuarter the importance of the LSI to commercialisation of research can be seen. Therefore, in this case, LSI support was valuable. However, when speaking with the Cell and Gene Therapy Catapult, which was also included in Case 4 LSIs, it was clear that commercialisation was the main focus, while KE was less important and only occurred as a side thought. It should be noted that the interview took place early in the life cycle of the Catapult, which was still in the set-up phase of its life cycle.

One of the LSIs interviewed in these sector specific thematic intermediaries - Case 4 LSIs was the Scottish Stem Cell Network, which had recently shut down. It should be noted that this LSI had begun in 2003 and at the time the requirement for them was to help companies to grow, however, no specific commercialisation targets were given by the funders for creating new entities.

In the Case 5 LSIs, which include a range of TTOs, there is some commercialisation taking place and a desire to increase this activity. Commercialisation also includes the licensing of technology and accessing grant funding for translational research. TTOs do engage in company creation and it’s this element that we see a desire to increase.

Although KEC is an embedded function in TTOs, and has gained momentum in recent years, it has become clear from this PhD research study that these LSIs have the potential to become high performing LSIs with embedded KEC activities driving them. Locke et al. (2005) said that some TTOs already have the expertise in-house to deliver tacit KE, but their inability to deliver both tacit and codified knowledge is preventing them from being seen as high performing LSIs. Two interview participants, Edinburgh Research and Innovation and Luris from The University of Leiden Medical School, are clearly focused on commercialisation activities and described how they had made it a priority to improve the processes.

Having explored each of the Case LSIs in terms of their perspective on commercialisation, we can see that the Case LSIs have different frameworks and targets for commercialising research and that despite this difference the LSI is important within the process. Some LSIs have managed to accelerate the commercialisation process. However, those LSIs that were solely focused on KE and did not have targets for commercialisation, have been perceived by their funding stakeholders as having less value and have closed when their funding life cycle ended.

This research study has shown us that commercialisation activities varied for each of the different LSI Case models. Indeed, commercialisation outputs included not just spin-outs, start-ups, collaborations and inward investment, but also patents and licensing of technology and finding funding for early stage companies; a wide range of activities of which some did all, some did a few, and others did none.

Something that should also be considered is the national innovation landscape and the factors that contribute to the success for companies. Rosiello (2007) said that, depending on the location of the cluster and the size of the companies, there may be a need for an LSI. His study looked at companies within Scotland, which needed the help of LSIs to access funding, plus customers and staff from outside of the country. This could also be attributed to the size of the company. We have noted in this study that fledgling companies require more support from an LSI than more established companies. Scotland has a higher proportion of smaller companies than the South East of England, which has a number of companies that are similar in scale to a small pharmaceutical company. These do not usually require support from an LSI.

7.3.2.2 RQ2. *What are the key perceptions and expectations that LSIs hold?*

The expectation gap was explored in this study and it was determined that the gap was created by the difference between the perceptions from stakeholders and reality (Figure 14).

The objective of measuring outcomes allows us to answer RQ2 in a more meaningful way. The metrics used were fairly simplistic and linked to the model of Case LSI. The following is a description of the metrics that were used for each Case LSI model.

- In Case 1 LSIs it was simply the number of tenants in their LSIs.
- In Case 2 LSIs it was case studies of successes and the number of individuals from academia and industry who had attended their KE events.
- In Case 3 LSIs it was spin-outs, but more importantly it was collaborations and research income.
- In Case 4 LSIs, it was the number of companies spun-out or created, the number of entrepreneurs they helped and research income
- In Case 5 LSIs it was the number of patents, licences and spin-out companies

Perceptions and expectations have a profound effect on these LSI Case models. In chapter 6 we discussed Forms of Telling, which helped the researcher delve into some of the revealing interviews provided. The data revealed the link to the funding life cycle of the LSI and how open they were about their LSI. Where they were in their funding life cycle determined the amount of open telling against more guarded telling. At the start of a new LSI, the interviewee would provide more strategic answers compared to those who were coming to the end of the life cycle or who had completed the funding life cycle and their LSI had closed. Through this process it was possible to delve deeply into what the perceptions and expectations were on the value of these LSIs.

Thinking critically about the range of LSIs and the RQ on expectations, we do need to take into consideration the age of the LSI and the funding life cycle of the LSI. The more recently created LSIs have had specific targets for KEC embedded within their LSI business model; this has reflected positively on their value and impact on KEC. Outwardly the LSIs chosen for this study appear similar, especially in their ability to bridge the gap between industry and academia. However, by using ConGTM in this study various components have been unravelled to reveal the main differences when trying to compare like with like. For example, these sector specific thematic intermediaries included the Scottish Stem Cell Network, which was created in 2003. We have already mentioned previously that the age of a LSI does have a relevance to whether KEC is fully embedded. No specific targets for commercialisation were set for creating new companies, but the network did support company growth. There was however an expectation from the funding stakeholders that this would be an outcome of the activities of the LSI. This then resulted in the LSI not achieving these expected targets and by 2013 when it shut down it were perceived as a failed LSI. The researcher has observed that the funders and policy-makers at that time appeared to not fully understand that commercialisation means many different things to different LSIs, and hence the expectation gap for this LSI was large.

The UK Catapults and the German Fraunhofer's are similar types of LSIs and many of the reports have noted the longevity of the Fraunhofer's. Whereas, in the UK we have had a series of intermediaries that have closed, and are considered failures. Why do we now believe that the UK Catapult Centres and the Scottish Innovation Centres will succeed where others have failed? This study has identified the gaps between expected and realistic targets that are set by the stakeholders. This means that if the targets are not met, the LSI is labelled as a failure. Therefore, in order to reduce the expectation gap funding stakeholders need to better understand what is achievable with the funds they provide to the LSI. If the Theoretical Concept Model is followed, the expectation gap will be reduced.

7.3.2.3 RQ3. Why do some LSI fail to survive beyond their funding stream?

This research question was identified from the literature in Chapter 3 of this thesis where we examined a few failed LSIs. These included the ITIs (Brown, Gregson and Mason 2016) and the Faraday Partnerships (Howells and Elder 2011, House of Commons Science and Technology Committee 2011). In the case of the Faraday Partnerships the research findings showed that there were two main causes for this failure: thinly spread funding and lack of engagement from industry.

Reviewing a few of those LSIs whose funding had ended, like the Scottish Stem Cell Network and Nexxus, it was interesting to note that they had similar experiences with engagement with industry. Both said that there was a need for their intermediary services from the SME community they served, but that larger organisations were either able to do things for themselves or were directly account managed by the regional economic development agency. This stands out as a misplaced expectation from the LSI's stakeholders that companies of all sizes would engage with the LSI.

The analysis in this study has showed that both Nexxus and the Scottish Stem Cell Network, which were not funded beyond their funding periods, were perceived as having failed to achieve expected targets for industry engagement. It is likely that the Faraday Partnerships were considered a failure for the same reason. In the case of the ITIs, Brown, Gregson and Mason (2016) claim that the failure was due to a fault in the design and that the design should have taken into account the local entrepreneurial ecosystem. For the ITIs some of this failure has been associated with the lack of agreement between industry and academia - in particular with regard to ownership of IP. The ITIs were created as not-for-profit companies and managed the funding with their academic partners. One of the issues was that they wanted to own the IP. This did not sit well with the universities.

When we looked at the Forms of Telling section in the last chapter we noticed a link to the funding life cycle of the LSI and its perceived success or failure. The researcher asked the question: if an LSI closes when it comes to the end of its funding, does that mean it is perceived as having failed? If so, are those LSIs that get a continuation of their funding and continue to operate then perceived as successful?

Despite trying to understand what failure and success means, the researcher has noted that the fact they have come to end of their funding is too simplistic an answer to the question: as to what constitutes failure? A few of the LSIs that shut down had been doing well, providing a service to SMEs who did not have the resources and know-how to accelerate their own growth. LSIs like Nexxus and the Scottish Stem Cell Network provided marketing channels and access to export markets as part of their offering. Should they have transformed their LSIs into fee paying networks like One Nucleus or would this have transformed themselves into something unrecognisable?

These public funded LSIs are high profile failures and fit right into what Oakey, West and Manchester (2007) claimed was interference from policy-makers to artificially grow these LSIs. They say that if the economic environment is right they will grow organically. This answer leads us right back to RQ1: are LSIs needed? And again, do we allow the LSIs we create enough time to develop, and if not, are our LSIs too early stage for us to make this judgement?

7.3.2.4 RQ4. How important is an anchor organisation to a LSI?

In the literature review it was noted that Hendry and Brown (2006) asserted that there was insufficient evidence to support the theory that companies succeed in a location because of the proximity of an anchor. This study has included a number of the LSIs that are located within a cluster containing an anchor. These included The Stevenage BioCatalyst, located on the grounds of the pharmaceutical company GSK, which has attracted a large number of SMEs. Rothamsted Research is another similar example with a world class research centre at the heart of a cluster.

Rothamsted is one of the Research and Innovation Campus (RICs) that was discussed earlier. They are supported and promoted by the BBSRC and are committed to this more traditional 'anchor' view. This view of an anchor organisation at the centre of a cluster is reinforced by Lawton-Smith (2005) and Kenney (1986). Owen-Smith and Powell (2004) who concluded that biotech spin-out firms are strongly dependent on PROs for skilled labour and novel scientific competencies that feed the fledgling SMEs.

The trend is definitely for LSIs to locate near to an anchor and it is unusual for it to be a standalone LSI. An exception to this is the Biocity LSI. BioCity is of the view that proximity to an anchor organisation is unnecessary, and that they could grow their incubator without being close to an anchor organisation like a hospital, university, research institute or large company (Gilding 2008). This is in line with the views of Hendry and Brown (2006). Their research looked at agglomerations of companies that link and interact, exchanging knowledge along the way and they concluded that one of the key features was access to suitably qualified staff. Hendry and Brown (2006) said that their study showed that companies performed no worse outside of a cluster. In the case of Biocity, although they have said they do not need to be located near to an anchor, they still concede they needed to be close to cohorts of qualified staff. For Biocity there is an agglomeration of companies within their incubator premises that also supply qualified staff, who can jump from one company to another. They do not qualify as a lone company as they are in a sense their own cluster.

An interesting comparator is the IT and creative hubs springing up in city centres around the world (Pickford 2013). They have been proposed as the incubators of the future, and are usually based in renovated buildings with labs and offices set up in a very flexible way, where would-be entrepreneurs who can rent space for a monthly fee (Grens 2014, One Nucleus 2016). These are simply ‘anchorless’ incubators that resemble the Biocity model and have become hugely popular.

In conclusion to this section we can draw from the existing knowledge and the knowledge gained from this study to see how the researcher has attempted to address the gaps in the existing knowledge within the substantive area. Additionally the answers to these research questions have helped to support the findings, including the emergent theoretical concepts that form the basis for the framework model that was recommended for new and existing LSIs to improve their performance in KEC. This is how the data that was collected has been re-constructed to bring new insights to the field of knowledge.

7.4 The Limitations of the Study

All research has limitations and challenges. The main challenge in conducting a ConGT study like this is the time it takes to complete the study.

> "*There are practical difficulties with grounded theory. The time taken to transcribe recordings of interviews for example can make it difficult for researchers especially when they have tight deadlines…" (Bryman 2012, p.574)*

In this study the lack of time resulted in the researcher being unable to return to the participants to do follow-up interviews. The decision to personally transcribe all the interviews - of which there were 30 - was the right choice as it enabled the researcher to get close to the data, rather than handing over the transcribing to someone else to do.

The area of innovation intermediaries is fast moving and things change rapidly. Some of the participants are no longer in post, as many have moved on or the LSI has closed its doors. Therefore, returning to the LSI to address any outstanding questions or issues would have been difficult.

It is completely understandable as to why there are so few ConGT business management studies available to refer to: it is a time heavy methodology. However, the researcher strongly felt that the theoretical concepts that emerged from the data to be of great value to the sector, especially to policy-makers and funders of LSIs.

Another limitation to consider is the subjective nature of qualitative research itself. While completing the analysis for this thesis the researcher noted a number of issues regarding the allocation of the LSIs between the Cases. On reflection it may have been better for Case 3 LSIs to have been places in Case 4 LSIs. Moreover, classifying Case 5 LSIs as Life Science specific was probably incorrect. The TTO LSIs that populate Case 5 work cross all technology sectors, but the TTOs chosen for this study have a strong focus on life sciences.

In summary although limitations are inevitable the researcher is sanguine that the quality of the research methodology has clearly answered the research questions and has met the aims and objectives of the research as set out in Chapter 1.

7.5 Recommendations for Further Research

The researcher's recommendation for future research in to GTM is not to fear the methodology, which appear quite daunting. The processes allow one to identify new ideas, and although the researcher would argue that new theories are very rarely if ever generated, it does bring out concepts that could be validated down the line as theory.

> "*When you theorize, you reach down to fundamentals, up to abstractions, and probe into experiences. The content of theorising cuts to the core of studied life and poses new questions" (Charmaz 2010, p.13)*

This study explored the intermediaries themselves rather than the companies within them. This produced a better understanding of the functions of a LSI and allowed the researcher to develop a theoretical framework to help them perform at their peak. The researcher recommends that more research is done to validate this research and to perhaps build on the findings. For example those LSIs that have shut down should be investigated further to build on the knowledge gained from this study. Any future research should consider the following:

1. How important are Commercialisation targets?

2. Should the LSI consider evolving rather than losing a strong brand when they run out of funding
3. How important is having the right leadership or a champion?
4. How do the LSIs manage the political landscape in order to keep going?
5. The relevance of branding especially for international brand awareness

Some of the 22 LSIs were deemed to be too early-stage to judge whether or not they were successful. Can success and failure be attributed to the funding life-cycle of the LSI? A longitudinal study would help to further validate what constitutes success and failure in these LSIs

A final recommendation is that the performance of Case 5 LSIs, the TTOs, should be evaluated for the potential to perform the KEC function to a higher level, which this researcher believes would reduce the need for the plethora of LSI models.

In Scotland there has in the past been a drive for all the TTOs to be centralised within one organisation. There was strong resistance from the academic institutions and the idea did not proceed. The TTOs asserted that centralising would mean the relationship to the academics would be lost. Clearly there is a lot of interest in TTOs and further research is inevitable. The TTOs scored badly in this study as a valuable LSI when compared to the other Case LSIs. As mentioned before they have the potential to do much more, and perhaps if they could carry out KEC activities more effectively there would be a less need for so many different LSIs. There is great interest in the TTO model from policy-makers, therefore a study that will measure their effectiveness in covering all aspects of KEC would be highly valuable (Higher Education Funding Council for England 2016).

7.6 Final Reflections

This study has made some solid contributions to the literature on innovation intermediaries. A framework model was produced that can be reviewed by funders and practitioners in the creation of new LSIs. Applying the five emergent theoretical concepts that have been built into the framework should help an LSI to become a high-performing one.

With regards to the question of generalisability, as this study follows the Sectoral Systems of Innovation (SSI) (Malerba 2005) it would not be possible to apply the framework to other sectors. It has been noted that even the support organisations working with this sector need to show they have some specialist knowledge in order to gain entry.

This research has shown us some interesting ideas relating to perceptions of success and failure. After the review of the literature on comparing innovation intermediaries (in particular the study carried out by Suvinen, Konttinen and Nieminen (2010) where the Optoelectronic cluster appeared to more successful than the biotechnology cluster) it became clear to the researcher that SSI needed to be applied. This was why all 22 LSIs used in this study came from the life sciences sector.

On reflecting on the data, including all the observations and memos, the researcher does believe that SSI should be used when doing a comparative analysis in the life-sciences sector. It would present more opportunities to find like-with-like comparisons; however even these may not be exact. The other discovery from this data was that within the sector itself a supplier to the sector who does not have specialist knowledge of the sector will find it difficult to gain a footing within the sector.

Another observation from the data was from one of the Cluster Network Organisations that had shut down, said they had been prevented from marketing their brand internationally. At the time of the interview the researcher had asked the participant if they thought this had any impact on their demise. There was no conclusion to be made, but the question was raised: were they perceived as unsuccessful because they were not well marketed internationally, for instance, some of the other similar Cluster Network Organisations, like One Nucleus and BioDundee, who do actively do marketing internationally and who therefore have a strong brand internationally, have continued to survive? We have seen that a number of factors could brand an LSI as unsuccessful. Not marketing internationally could be one, the reasoning for this is linked to the fact that the markets for the majority of life-science companies are overseas. They are keen to gain access to international markets with the support of the LSI. If this is not a service offered, then the LSI could be perceived as having failed.

This final chapter concludes the thesis. It started by reviewing the aims and objectives that were originally outlined in Chapter 1. Next the four research questions were addressed and linked to the literature reviewed. The limitations were discussed and areas for future research were suggested, and then the final reflections from the researcher with some further critical thinking on the study outcomes were made.

Thinking critically and with the empirical data from this study, we have tried to explore why we have had so many LSIs come and go. This has led to the discussion surrounding the question as to what constitutes or defines success and failure. On analysis of the data using a Constructivist Grounded Theory Methodology the researcher was able to interpret the re-constructed data in order to answer the RQs that are linked to the overarching question of why we have had so many LSI come and go. She found that there were two pathways to being labelled a failed LSI. The first one relates to those LSIs that have survived for longer periods, like One Nucleus for example, and who have done so by evolving their business model, also known as a paradigm shift. Those LSIs who have not done this have found that despite having been considered successful, they have still closed down without further funding. These latter LSIs are considered failed LSIs. The second path to failure is when a LSI does not meet the expected targets set by the funders. Here the LSI had an expectation placed on them to achieve targets that they were not resourced to achieve. In some instances the researcher believes there has been a misunderstanding of what a commercialisation outcome should look like. We have noted that for all the 5 Case LSIs commercialisation outputs are different.

The hope had been that this study would reveal some of the key factors that allow for high-performing LSIs with embedded KEC activities to be successful. The framework model that has emerged from the data has achieved this. The one factor that struck a chord with the researcher, was that of time. Based on the empirical evidence and the literature many of the LSIs have not been allowed the luxury of time in order to iron out the kinks. If we want to be comparable to the Fraunhofer Institutes we must allow these LSIs time to re-align themselves

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Appendix 1: The Interview Consent Form

Consent Form

(Face – face interview with audio-recording)

Name:

Organisation:

Date:

This interview will be conducted for the purposes of gathering the views of the interviewee on the subject of Life Sciences Intermediaries.

Informed consent is an ethical requirement and this has to be sorted and agreed to by the participants of the interviews for this research. The information provided must be freely given on a voluntary basis and it must be understood that the information will be stored and used for the purposes of this research. This means that the content of this interview will be used in published journals or be used within the PhD thesis of the interviewer.

Your identity will be made anonymous if desired. I can also guarantee commercial confidentiality where appropriate if required. This will be agreed verbally.

Permission to audio-record this interview is requested. If you agree please initial here ___________.

You are free to stop the audio-recording at any time and are free to decline to answer any of the questions at any stage of the interview.

I agree to participate in the interview required for this study____ (a copy of this will be given to you)

If you have any further questions, you are welcomed to contact me Deborah Spencer PhD Researcher at 1201563@live.abertay.ac.uk or phone me on 07949472399

Appendix 2: An example from the Interview Transcript

(4/7 pages from the original document)

Science Park

DS: Can you provide a historical background to the Science Park

PSP: We coming up for the 20th anniversary developed for the new home for The Institute Research institute which had survived for 70 years in the centre of Edinburgh, but in terms of the facilities had become quite antiquated and now fit for purpose and development had surrounded the institute and this site was acquired from the University and the park was built between 1994 and 1999 basically and then The Institute moved out here 1998. SE and Lothian council were involved in the build it was pretty dramatic as the local area had been important in the mining industry. So this area of science was beginning to become important and so between SE and Lothian it was decided to build a science Park – a research commercial organisation that could produce jobs and economic value for the area, but also interact with the Institute Research Institute to derive benefits.

Ds: So just to clarify the Institute Research Institute is at the heart of this science park,

PSP: Yes its animal health, farm disease, [redacted] is really important with the [redacted] but we're important in terms of animal health, but don't shout as much in terms of livestock disease we are trying to cure diseases or existing diseases in livestock. In terms of animal behaviour we are focused on curing them, we are also looking at exotic diseases and trying to cure these too.

The Institute research Institute was at one time funded by the Scottish Government, but now it's just under 50% funded by the Government. So The Institute has to generate funding from other resources

DS: When did it reduce to 50%?

PSP: It's been 50% probably for the last 5 years but has been in decline since the 70s and there's much more commercial development has an institute so its developing strategic partnerships with the animal health industry and pulling in money from that direction and also pulling in commercial grants from any where we can including the BBSRC, DEfRA, Wellcome Trust, which helps fund the institute and we have developed a fantastic track record in doing and we continue to do that.

In recent times the Institute has changed its focus aside from animal health their main object and now we aligned yourself with food security linked to the ever increasing population and the link to protein and meat. So healthy animals or disease free animals will produce more food and will make a contribution to the population. Our director Julie Fitzpatrick she has a chair at Glasgow University in Food security so then we're looking at ways to develop that field and to generate new revenue streams from that. So aside from the research institute the Institute group has 2 commercial subsidies –The Institute which is a commercial company and they animal health work on behalf of the industry and studies on animals including vaccine developments, they have also developed a safety testing service over the last ¾ years. Animal health is very cyclical with ups and down and for whatever reason animal health has turned off and difficult times have ensued

So we created [redacted] limited so the university helps us manage it to help develop relationships between the science park tenants and The Institute. The Science Park is owned by the Institute Foundation which is a charity and in 4 months' time we will have paid off the mortgage! So debt free. So [redacted] limited manages the science park on behalf of the Foundation.

Aside from that we try to keep the park full and ensure that people pay their rent and also that there are support services on site, things like security, catering, waste disposal and IT support all these things. So all these services are provided for the Institute group and for the tenants and some of the tenants can opt in to buy services but some services are mandatory others are paid for on a user basis, what this does is free up the tenants from having to worry about these types of services so they can focus on their core work.

DS: Can you tell me a little more about the Institute Foundation, Who are they

PSP: The Institute Foundation is a just a disease association they are a charity and the end of the Institute family tree their aim is to raise funds to sponsor and promote research in animal disease. The main source of income at the moment is from the science park, their income is roughly £2.5 million per year so the KE work is driven through the Foundation there's a communications team here, who organise various activities, newsletters 3-4 times per year to the members they update members on the science and can focus on a particular disease or general instruction or recommendations on animal welfare or husbandry that can be useful for the farmer in trying to minimise disease in the livestock. The Foundation has representative across the UK and board members from across the UK who discuss livestock issues in various parts of the country. This information is fed back to the main research board and will influence the direction of the sciences. Every year The Institute take a road show to every part of the country they address issues in various regions of the UK.

DS: So A local and regional understanding of the science. Great!

PSP: We get feedback that enables us to focus on specific animal husbandry and welfare issues. The Institute has influence in the main livestock countries around the world. Lots of our senior scientists attend conferences on a regular basis and speak at events and then the next week we're about to launch a vaccine in Australia and it target virus in the sheep stomach and our scientist cracked the problem so we set up a company called [redacted]. In the past the vaccines that The Institute has developed we've tended to license them out to the animal health industry they get manufactured and The Institute would get the royalties. Like most people we've tried to retain the value by taking the process as far as you can, so we are going to produce the vaccine in Australia and we have an agreement with a distributor to get the vaccine out and we hope to get a modest income back from this. So we have all the regulatory approval for the product and it's due to launch on the next 2 weeks so it's quite exciting and should be a significant revenue stream.

DS: You are only focused on animal health companies?

PSP: So we were focused, but there are other general LS companies here. And there is a pharmaceutical. They must have R7D or manufacturing to be here.

DS: How did you work with Biosciences KTN, did that intermediary sit well or did

PSP: I don't think there was much engagement with this KTN.

Ds; It would be interesting to know the engagement that went on here as the Government decided that this area needed a specific intermediary. Now considered failed. (Will get back to me on this)

PSP: I have been at the PSP for 13.5 years now

DS: When you started were they more focused on companies in animal health and welfare or were you already to see general LS companies locating here?

PSP: So while the development of the SP had been successful the early management of the SP had not. When I got here the Park was in a bit of a mess, people weren't paying for services, so it was becoming unsustainable. So we had to change the management we were managed externally by The Institute Company that had spun out New Park, so a decision was taken at board level to terminate that contract and engage an in-house staff who would be a 100% focused on the Park. So at that time I focused on making the park sustainable and paid for and that process included to make sure the park was full so some of the ambition to have an innovation centre kind of fell by the wayside because we had to focus on income. So for the period we didn't have an active incubator as such because it tended to be occupied by more established businesses rather than smaller ones we've had some start-ups who have come in. At that there were only 2 start-up businesses on the park. It has flourished and moved on it was animal health related or even LS it was more materials consultancy. Which meant it needed lower cost space than a science park so it moved to a lower cost site. The Docherty centre was originally the innovation centre (incubator) so had flexible space so the idea was that it would grow.

DS: So it followed the normal trajectory for new innovation companies they go into an incubator grow and then move into a SP. So your incubator failed.

PSP: Not necessarily, I guess you wouldn't expect lots of businesses to spin out of animal health

DS: So do you have spin-outs occupying the innovation centre now?

PSP: Sometimes but the challenge that we have with start-up sand spins-outs have been initially set up by the university and then been allowed to incubate in university labs and when you quote the price to them they run a mile because they're just not used to it.

So once you start to quote £10.00 per sq ft they feel they can't do it so they go to a corner somewhere else. So this is one of the major challenges for SPs they are not one of the cheapest places to locate in terms of costs.

We need to persuade them it's worth paying that little more for as there is added value in being here that is something that all SPs continue to struggle with. I think increasingly certainly through the recession it impact on cost and occupation.

PSP: Other parks can compete by cutting the price. Lots of consultancy businesses don't need lots of space so they don't need a SP. Out in the west of Scotland the sp there offered 7 years rent free to tenants which we couldn't compete with them.

[redacted] and people who built incubator put money into the company to make it happen, so they relocated. Seems a bit cut throat.

For this space here we took a lot of loyalty tenants at that time we qualified for ERDF funds so we had funds for fit out units. So for every pound that we spent we got 25p back, so if we spent £400K on fitting out and we could claim £100K back. There were a number of qualifying aspects to that grant in terms of how many jobs you were going to create. That came to an end in 2007 and it came to a point where The Institute was having to spend money to get money back and there was only so much that [redacted] could undertake and that was one of the issues that caused The Institute to get into any difficulties, so that why we only did so much of that. We did one for SNBTS they came on site here with a product testing unit and another for [redacted] technology another success was with [redacted] and that was a genuine and this was a genuine The Institute spin out. It was set by a retired scientist just a [redacted] but within 1 year turned into a 35 man company with a £2million turnover after 10 years. They are still here doing their testing, but have moved to the [redacted] Technopole.

Ds: What other objectives does the foundation have?

PSP: I think the aims of the foundation are pretty true to their cause clearly generating income for the research institute remains absolutely fundamental because it drives so much activity here on the site, so we have to continue to sustain the size of the institute which is actually critical to the whole SP. So the strategy now is to be more commercially focused as our Govt funding will continue to be reduced.

DS: Do you have plans of how you're going to generate this income/ shortfall?

PSP: The actual plan is to actually build a commercial hub building, we want to develop the KE initiatives we try to influence promote farming through education and the arts and so on and the case for putting exhibitions that highlight what we do. We've also being trying to develop with Lothian council stronger links with schools to encourage school kids to look at animal health as a career path. But also to look at the SP there are vast variety of jobs available here from researchers, stockman, to technicians to finance people to caters, cleaners you name it so there are lots of different career paths here so I'm trying to develop these aspects.

So they've created a business enterprise team to exploit the work going forward and to do that we want to create a commercialising hub so we want people to come in and interact. So there will be an interface. One of the issues which have never really bothered us is that the front door is at the back of the building. So if we create a hub building will seem open, so as people drive in they will see it attractive to potential collaborators and interactive area. We have a design in plan to make it a roll on type design so that will be a kind place where you can have a more relaxed one to one or where you can have wider groups including people from Pfizer or students and we have enough space for 20-30 people . Make presentations and we will have an enterprise team under the communications team.

We have a lecture theatre that holds 120 people so we can conferences too. Part of the plan for this hub is to possibly expand the size of the lecture theatre. So maybe increase it to take 200 people. We have 3 design proposals that have been submitted. We don't want it to be too ostentatious because what I want it to be is a place for farmers and scientists – so down to earth folk we don't have fancy expensively designed buildings the buildings are fit for purpose. Impressive but modest at the same time. So this will increase our commercial focus that The Institute has to have moving forward.

Obviously there is a lot of development at [redacted] with the university and the [redacted] The Institute has always argued to not develop new facilities when we already have these facilities here

MEMO-**Not sure this is good use of tax payer's money. the universities and institutes will take the money if offered, but should they. Clearly there is some duplication going on here.**

Julie is on the board that has decided the Easter bush development but is not in agreement with it. What [redacted] does, what The Institute does and the Scottish colleges SSE they are looking for new accommodation and Julie has been trying to persuade them to come with us and that's still going on.

Appendix 3: Ethical Application and Approval

Dundee Business School

Research Projects (Staff and Students) – Application for Ethical Approval

For Ethics Committee Use Only			**Indicate section(s) where corrective action is required**	
First Submission				
Reviewer 1	Indicate Decision : Accept Reject		Section 1	Section 5
	Initials :	Date :	Section 2	Section 6
Reviewer 2	Indicate Decision : Accept Reject		Section 3	Section 7
	Initials :	Date :	Section 4	
Second Submission				
Reviewer 1	Indicate Decision : Accept Reject		Section 1	Section 5
	Initials :	Date :	Section 2	Section 6
Reviewer 2	Indicate Decision : Accept Reject		Section 3	Section 7
	Initials :	Date :	Section 4	

Prior to the completion of the Ethics Form you must read the documents: "Ethical Review Procedure' and "Research Ethics Sub-Committee Remit"
(https://portal.abertay.ac.uk/portal/page/portal/University/Schools/DBS/SchoolAdmin)
There is also a 'Quick Guide to Ethics Procedures' on the same site.

Name of Student: Deborah Spencer	**Registration Number: 1201563**
Name of Supervisor: Professor Reza Kouhy	**Module Code:**

Or

Name of Staff member:	**Staff number:**
Is this an annual continuing ethical approval request?	**Yes** ☐ **No** ☐

SECTION ONE: Nature of the research

1.1 Project Title and Aim

Proposed Title of Project: **An Investigation of the role of Life Science Intermediaries and their Potential for Knowledge Exchange and Commercialization** **Main Aim of Study:** The aim of this PhD is to gain an understanding of the role of life science specific intermediaries and the value they bring to companies in the sector. The fundamental question in this research is do they help to provide competitive advantage by stimulating entrepreneurialism. Specifically what is their potential role in the knowledge exchange and commercialization (KEC) process? This question will be crucial in understanding their overall value in terms of economic and societal benefits. In order to decipher their KEC potential a closer look at the relationship between the LS intermediaries and the actors within the networks they operate in will help to determine the level of KEC potential within each intermediary case being investigated in this research. The main source of funding for intermediaries comes from public funds; however there is evidence that there are new innovative mechanisms for funding them, which is especially important in the context of the current economic climate.

1.2 Will your research involve any ethical issues?

Yes ☐ **No** ☒

If so, tick all relevant boxes below and explain on a separate sheet how you will address each and every issue ticked.

☐ financial or other form of reward for participation ☐ vulnerable people, e.g. children, juveniles, patients, those in care, those with only elementary English language, or with learning difficulties etc. ☐ people in custody or engaged in illegal activities ☐ cross cultural issues (e.g. language, images, content, etc.) ☐ sensitive topics (e.g. drugs, sexual orientation, ethnicity, age, political/religious beliefs, euthanasia, poverty, or conflict situations, etc.)	☐ offensive issues – i.e. race, colour, creed, etc. ☐ use of audio or video recorded materials ☐ legal issues (e.g. criminal records) ☐ media coverage ☐ reputation of the University ☐ **Other** (please provide full details, using a separate sheet if necessary)

1.3 Is your research to be based solely on a review of literature and/or secondary data, i.e. without any fieldwork or off campus activity?

Yes ☐ No ☒

If YES give details of sources to be used and whether permission, if required, has been granted to use resources

If YES then go directly to Section 7 (You need submit only these pages and Section 7)

For Ethics Committee use Only	Researcher provides a clear statement of the aim of the study?	Yes ☐ No ☐
	Action required:	

SECTION TWO: Research method

2.1 Give details of your Research Methods, e.g. use of questionnaires, interviews, surveys, observation, or other instruments or methods intended to collect data from or about people **(attach a separate page if necessary)**

The research methods will include interviews (semi-structured interviews), observations, documentary evidence and questionnaires

2.2 Who are the intended research participants? Please indicate approximate numbers

They will include: (7) CEO's or Directors of the intermediaries, (10) Business Development Managers, (4-5) Senior Managers from Economic development Agencies in UK, France, Holland and USA, (3) Policy makers and (4) Venture Capitalist/angel investors

Chapter 8

Chapter 9 2.3 How will you recruit / contact your research participants?

I will make contact initially by email to introduce myself and to inform participants of my research and what I'm looking for from them. I will use a meetings and conferences to arrange interviews with participants. In December 2013, I will be travelling to Holland and hope to conduct a few interviews then. In Feb/March 2014 I will travel to France and again collect a few more interviews and make some observations. In June 2014 I will attend the Bio2014 conference in the US. I intend to pre-arrange as many interviews as possible prior to the conference.

Chapter 10

Chapter 11 2.4 Please confirm that you will provide a copy of the permission sought in order to do so, prior to undertaking research

Signature	Date

Chapter 12

Chapter 13 2.5 What is your intended research site?

Chapter 14 i.e. where will research be conducted, what type of organisation/facility, etc.

The data collection will take place at the participant's office. This may be in Scotland, England, Holland, France or in the USA. The organisations I will contact include Bio-incubators, science parks, Pharmaceutical companies, Biotech Companies, Network orgamisations and Universities.

The Bio2014 conference in the USA has conference meetings rooms held by Scottish Enterprise that can be booked and used for interviews.

Chapter 15 (attach a separate page if necessary)

For Ethics Committee use Only	Section 2: Data collection methods are clearly identified?	Yes ☐ No ☐
	Action required:	

Chapter 16 SECTION THREE: General ethical issues

You indicated at 2.1. above that your research will involve the use of questionnaires, interviews, surveys or other instruments or methods intended to collect data from or about people. As a result, your research raises automatically the following general ethical issues

informed consent	voluntary participation
opt out by participants	confidentiality
anonymity of participants	privacy of participants

The normal protocol for addressing these issues requires the researcher to undertake certain activities, as specified at 3.1 to 3.9 in the table below.

Please place your initials against each and every item in the table, to indicate that you will comply with this protocol.

If you feel that you are unable to comply with an item in this protocol, please explain in detail, on a separate sheet, why you are unable to comply with that item and how you propose to address the underlying ethical issue addressed by the item.

		Initial
3.1	I agree to provide the participants with a written/oral explanation of the project and the uses to which any data will be put	
3.2	I confirm I will explain to the research participants that I am a student and undertaking degree studies	
3.3	I confirm that I will explain to the research participants that they may not benefit from my study, except to the extent to see summary results of the study if requested.	
3.4	I confirm that the subject will be made aware of the length of time it will take to gather data e.g. fill in a questionnaire etc.	
3.5	I confirm that I will explain to participants that their participation is voluntary.	
3.6	I confirm that I will offer to the research participants the opportunity to decline to take part in any part of the research activity. Participants, for example, may decline to answer a particular question in a questionnaire.	
3.7	I confirm that I will offer to my research participants the opportunity to withdraw at any stage, and explain to them how data will be withdrawn that pertains to them.	
3.8	I confirm I will offer to my research participants a guarantee of confidentiality, including commercial confidentiality where appropriate and if required	
3.9	I confirm I will offer to my research participants a guarantee of anonymity	
3.10	I confirm that I will provide, if required, evidence that I complied with the above protocol, eg by submitting a copy of my consent form, and completed consent forms.	

For Ethics Committee use Only	Protocol will be observed for addressing general ethical issues?	Yes ☐ No ☐
	Action required:	

SECTION FOUR: Additional ethical issues

4.1 In your research, could any of the procedures adopted cause any form of harm (including discomfort, stress, anxiety or embarrassment) to the participants?

Yes ☐ **No** ☒

If YES, please provide, on a separate sheet, details of

4.1.1 the potential harm to participants,
4.1.2 measures proposed to minimize the impact of such harm, and
4.1.3 how you propose to inform participants of the potential risks to them and to secure their consent to participate under those conditions

4.2 Will you be collecting 'personal data', i.e. anything (such as a name, address, phone number or description) which could allow a third party to identify participants in your research?

Yes ☐ **No** ☒

If YES, please provide, on a separate sheet, details of how you will comply with the requirements of applicable data protection legislation

For Ethics Committee use Only	Question of additional ethical issues has been addressed in a satisfactory manner?	Yes ☐ No ☐
	Action required:	

SECTION FIVE: Risk Assessment

This section is concerned with risk to **you**, the researcher. It is **not** concerned with risk to research participants; that topic is considered at question 4.1 above.

Risk is defined by reference to the potential physical or psychological harm, discomfort or stress that the research project might generate for **you**. You must consider if you are: working alone, in unsatisfactory working conditions, potential harassment situations, working in vulnerable situations or if your research will involve overseas travel, etc.

You must complete this section for you to obtain ethical approval.

Note that it is not acceptable to simply enter "no risk" in the table below. If you believe that there is no risk of any harm to you, you must explain why not. For example, if you are conducting a survey, with all the survey work being conducted on-campus, make a statement to that effect.

Chapter 16 IDENTIFED RISK (harm, hazard, things that need 'control', e.g. potential incident/accident, exposure to dangerous situations)	**Control Measures to Reduce the risk and/or Action to be taken in Emergency**
No personal risk during face to face interviews	**All interviews will be conducted at the interviewee's place of work during office hours and will be arranged by appointment.**
Accident or other incident while travelling to and from interviews	**All travel will be by recognized public transport or by own car, which is fully insured**
No personal risk Interviewing participants at international conference	**Conference based interviews will be held at Scottish Enterprise meeting rooms at venue during conference hours**

	Use a separate sheet if necessary

For Ethics Committee use Only	Risk Assessment has been addressed in a satisfactory manner?	Yes ☐ No ☐
	Action required:	

SECTION SIX: Declarations

		Initials
6.1	I confirm that I have read and understood the School's Ethical Review Procedure document and Quick Guide to Ethics Procedures	
6.2	I confirm I understand the need for Data Protection and undertake to abide by the regulations.	
6.3	I confirm that the health and safety of the researcher has been taken into consideration prior to the commencement of the research.	
6.4	I confirm that the research undertaken will not discriminate against participants on the grounds of race, sex, religion or belief, sexual orientation, disability, pregnancy and maternity, gender reassignment, marriage and civil partnership, and/or age.	

Student Signature …………………………… Date: …………………….

The research Supervisor signs to indicate that the researcher has 'considered' appropriate ethical issues and their own safety. The supervisor is not attesting to the adequacy of such consideration, merely that the student has confirmed that ethical issues and issues of personal safety have been considered by the student.

Supervisor Signature …………………………… Date:…………………

SECTION SEVEN

To be completed ONLY if the research is to be based solely on a review of literature and/or secondary data, i.e. without any fieldwork or off campus activity

7.1 Can you guarantee that your research will involve only literature review and/or desk research, i.e. without any fieldwork or off campus activity?

Yes ☐ **No** ☐

7.2 Have you read and understood the School's Research Ethics Committee's "Ethical Review Procedure", "Research Ethics Sub-Committee Remit", and 'Quick Guide to Ethics Procedures'?

Yes ☐ **No** ☐

7.3 Can you guarantee that you will comply with the University's policy on Academic Deceit? https://portal.abertay.ac.uk/portal/page/portal/University/Schools/DBS/SchoolAdmin

Yes ☐ **No** ☐

Student Signature …………………………… Date: …………………….

Supervisor Signature …………………………… Date:…………………

Copy of Letter of Approval.

Dear Student

This is to notify you that you have been granted **full ethical approval** to collect data for your project. This is subject to the following conditions:

i You must remain in regular contact with your project supervisor

ii Your supervisor must see a copy of all questionnaires, survey materials etc and your procedure prior to commencing data collection

iii If you make any substantive changes to your project plan, you must submit a new ethical approval application to the Committee. Application forms and the accompanying explanatory document are on the Intranet. Completed forms should be handed in to the School Office, Room 2015, Level 2, Old College.

Failure to comply with these conditions will result in your ethical approval being revoked by the Ethics Committee.

Should you have any queries please contact your Supervisor.

Yours sincerely

Appendix 4: Case 2 Interview Questions

Semi-Structured Questions for Cluster Network Intermediaries

- Please provide some historical background to your intermediary
- What type of model of funding do you use (PPP, self-financed,, ERDF etc)
- What are/were your strategic aims
- What funding mechanisms did you have or do you have?
- What was or is your relationship with the academic community?
- How inclusive are you or were you able to be?
- Describe your interactions with the business community
- What impact does/did your brand have?
- Did you aim to assist with international activities?
- Did/Do you have a programme for Knowledge exchange?
- What achievements have you had or did you have?
- How do you or did you measure success?
- What are the barriers to success?
- Did/do you play a role in the commercialisation process?
- What are/were the expectations from your various stakeholders
    - Government
    - Business
    - Academia
    - funders

Appendix 5: Case 1 Interview Questions

Questions for Science Parks and Incubator LS Intermediaries

- Please provide some historical background to your intermediary
- What type of model of funding do you use (PPP, self-financed,, ERDF etc)
- What are your strategic aims
- What mechanisms for income generation did you have or do you have?
- Do you have plans to evolve the site? Eg going from incubation units to science park
- What is your relationship with the academic community?
- Describe your interactions with the business community
- What interactions or relationship do you have with TTO's
- How inclusive are you able to be?
- What are your thoughts on mixed sectors within your intermediary?
- What impact does your brand have?
- Do you assist with international activities for any tenants/spin-out/start-ups?
- How do you rate inward investments? Have you looked at the economic impact and potential long term impact of inward locating organisations?
- Do you have a programme for Knowledge exchange?
- Do you play a role in the commercialisation process?
- What achievements have you had?
- How do you measure success?
- What are the barriers to success?
- How do you rate the benefits of alliances with other nations, do you think they would benefit the commercialisation process?
- What are the expectations from your various stakeholders
    - Government
    - Business (various sizes)
    - Academia
    - Funders

Appendix 6: Case 5 Interview Questions

Semi-Structured Questions for Technology Transfer Office Intermediaries

- Please provide some historical background to your intermediary
- What type of model of funding do you use (PPP, self-financed,, ERDF etc)
- What are your strategic aims
- What mechanisms for income generation do you have?
- What is your relationship with the academic community?
- How inclusive are you able to be?
- What other Life Sciences intermediaries do you interact with?
- Describe your interactions with the business community
- What impact does your brand or office have?
- Do you have a programme for Knowledge Exchange?
- What achievements have you had?
- Do you aim to assist with international activities?
- How do you rate inward investments? Have you looked at the economic impact and potential long term impact of inward locating organisations?
- How do you rate the benefits of alliances with other nations, do you think they would benefit the commercialisation process?
- How do you measure success?
- What are the barriers to success?
- Do you play a role in the commercialisation process?
- What are the expectations from your various stakeholders
    - Government
    - Business
    - Academia
    - Funders

Appendix 7: Case 3 Interview Questions

Questions for Research Institute Campus Intermediaries

- Please provide some historical background to your intermediary
- What type of model of funding do you use (PPP, self-financed,, ERDF etc)
- What are your strategic aims
- What mechanisms for income generation do you have?
- Do you have plans to evolve the site? Eg to grow
- What is your relationship with the academic community?
- Describe your interactions with the business community
- What interactions or relationship do you have with TTO's
- How inclusive are you able to be?
- What are your thoughts on mixed sectors within your intermediary?
- What impact does your brand have?
- Do you assist with international activities for any tenants/spin-out/start-ups?
- How do you rate inward investments? Have you looked at the economic impact and potential long term impact of inward locating organisations?
- Do you have a programme for Knowledge exchange?
- Do you play a role in the commercialisation process?
- What achievements have you had?
- How do you measure success?
- What are the barriers to success?
- How do you rate the benefits of alliances with other nations, do you think they would benefit the commercialisation process?
- What are the expectations from your various stakeholders
    - Government
    - Business (various sizes)
    - Academia
    - Funders

Appendix 8: Case 4 Interview Questions

Semi-Structured Questions for Thematic Intermediaries

- Please provide some historical background to your intermediary
- What type of model of funding do you use (PPP, self-financed,, ERDF etc)
- What are your strategic aims
- What mechanisms for income generation do you have?
- What is your relationship with the academic community?
- How inclusive are you able to be?
- Describe your interactions with the business community
- What impact does your brand have?
- Do you aim to assist with international activities?
- How do you rate inward investments? Have you looked at the economic impact and potential long term impact of inward locating organisations?
- How do you rate the benefits of alliances with other nations, do you think they would benefit the commercialisation process?
- Do you have a programme for Knowledge Exchange?
- What achievements have you had or did you have?
- How do you measure success?
- What are the barriers to success?
- Do you play a role in the commercialisation process?
- What are the expectations from your various stakeholders
    - Government
    - Business
    - Academia
    - Funders

Appendix 9: An Example of the Initial Coding

Case 2 LSIs are Life Science specific Cluster Network Organisations, these include the following:

- One Nucleus covers the SE Of England and was created in 2010 by the merging of the London Biotechnology Network and the Eastern Region Biotechnology Initiative (ERBI), centred in Cambridge. One Nucleus is a membership organisation, whereby members have to pay a fee depending on the size of their organisation to join.

- BioDundee covers the Dundee region within Scotland and was the second UK cluster networking organisation to be created within the UK after ERBI. This organisation is free to join and has been funded by the European Regional Development Fund and Dundee City Council. They receive nominal amounts of funds from some of the members including the universities and institutes.

- LyonBiopole is a cluster networking organisation that straddles the region of Rhone-Alpes and encompasses the cities of Lyon and Grenoble. Their network like BioDundee is also referred to as an umbrella organisation and have 17 institutes and 168 life sciences SMEs. Within LyonBiopole there are four biopharmaceutical companies that contribute towards the funding. However, the main source of funding is from the regional and National Government.

- Nexxus is a cluster network organisation that has now closed. It started in Glasgow and was based within the University of Glasgow. They had funding from Scottish Enterprise, European Regional Development Funds and the local council. They eventually expanded to include Edinburgh and were talking to BioDundee to join forces with them in order to cover the East Coast of Scotland.

Case 2:	Cluster Network Organisations
	LyonBioPole Rhone Alpes Region France
	BioDundee
	Nexxus (Glasgow and Edinburgh)
	One Nucleus (South East England, London and Cambridge)

Initial Codes

1. **The life cycle of the project/funding**

<u>Coming to an end</u>

2b: We never stand still, it changes from year to year adapting to what the needs are, which is why we're looking at widening out into the healthcare and beyond biotechnology, because that fits with the LS strategy and also what we believe might be the economic opportunities locally, we have a big teaching hospital and a university, it's not just about LS it's also about healthcare.

MEMO – this LSI has been in existence for 17 years. One of the reasons they have survived is their ability to adapt to different needs.

Just starting

2. **Engaging stakeholders**

Engaging with academic stakeholders

2a: Universities may be members. We do host academic conferences. One of board members came out of IBM and decided that we needed to engage with academics and the importance of working with academia. We have workshops etc that they engage with. Our membership is very broad and covers lots of different areas of the LS including oncology infectious diseases.

2b: One of the things that helped Dundee to move forward was that we had identified that we had these kinda superstar scientist, who were willing to back the idea of this life science community to just beyond the walls of the university.

2b: We've tried to work with the academic agents and do it in a way that they're happy with, so for eg with University of Dundee it is RIS and they can act like gatekeepers, well that's their role and that's fine, they're the ones who give us funding so we have to work around that.

2b: With Abertay it was much more an academic perspective that they were interested in from their students etc. From the James Hutton it was the commercialisation arm of MRS that actively engaged with us.

2b: Over the years we've managed to create stories and heroes out of scientists , which the scientific community has recognised and has been grateful for and has understood that it helped them as well as helping us, so there's a win there . For example would Philip Cohen have had such a high profile in another city?

2e: We had an excellent relationship with the academic community, mostly because everything we did was free to attend and its incredibly difficult for academics to find the money unless it comes out their own pocket to attend something.

2e: The typical spilt of people attending events was around 50:50 and we had a high profile amongst academics at that time

MEMO- all their events were free, so they had a high proportion of academics attending

2e: In terms of academia we worked with them right across the board. WE used to networking skills events with a particular focus on young researchers to get them to understand how they can work with industry and what they have to do is networking,

Engaging with Industry stakeholders

2a: At the moment we've 470 organisations as members and 130 of those are R&D companies mainly London/Cambridge based, the rest of the membership are commercial service providers. So historically the companies have been from London Cambridge corridor and those who have joined us want access to these R&D companies. So the bottom line is we have so many members because of our R&D companies.

2b: you know we've got the steering group and everyone is invited onto the steering group from every sector, so that's up to them. If they're not getting what they want then they need to be part of it.

MEMO- Members from across the sector are invited to join the steering group and have their voice heard. Attendance from industry has not been good in recent years

2b: That has changed slightly because in the area because we used to work much more closely with [redacted] as they had a local focus, there was a lot more Bus Dev activity in terms like working with companies and that doesn't happen anymore . The companies we work with are the ones we've met through the networking and have identified through networking. We are careful not to step on the toes of the account managers with [redacted] so there's no point us getting in the middle of that. The companies might come to us because they require some skills requirement, that's where we would step in with a one to one agreement, but I think it has changed because [redacted] don't have so much money locally. We need to make sure they know what's going on locally, like they attend the steering group, but we're not clear what for.

MEMO- engagement with industry appears to be non-existent now. It has very little involvement with any real engagement with companies, except through training and skills and networking opportunities.

2e: I would say especially for the business side that we were more focused on the SME than the large industry and this is more because of the types of things we used to do. For small companies important information on things like access to Clinical Trials, IP and funding mechanisms.

2e: [redacted] offices would be working with. They would be working with kind of driving at the top highegians working with large pharma, large corporations. That said a lot of the PR and marketing that they used to do was for smaller companies and individuals.

MEMO- SE are looking to work with more established firms, which leaves a gap for the less established firms to get support from Nexxus

2e: We were also able to do free PR and Marketing for companies, so we had a whole series of case studies, where we went round and interviewed key figures in an organisation, or we'd have a press release or a marketing piece on an organisation where they didn't have that kind of budget or capabilities for it in house.

3. The power of brands

2b: Well we're not being killed off anymore because [redacted] have decided that they don't want a brand. So what we have is a very strong band because we've used it consistently and how reputation is completely side by side. The brand would be worthless if we didn't have such good reputation in life sciences sector internationally and the alliance with the University [redacted]

2b: So we haven't tinkered with it we haven't ermm it's still our brand and ask if it's still relevant to the sector we ask ... because it is [redacted] and because it geographically places us, that's why we invest in it. Local initiatives are really important, because that's where you get buy-in from politicians from the local community, we're much closer to hand to understand the problems and have that sense of community. Although in Scotland it's not hard to do that. So there is a Scottish LS community, but saying that underneath that there is a heart which is [redacted], I think.

2b: The brand is internationally recognised. People have heard it.

2e: Significant impact on a national level I would say. People were aware of what we did, certainly in Glasgow and in the greater life science community across Scotland. We didn't have much of a profile outside of Scotland. We did have traction with SDI offices globally, so some of those offices used to receive the [redacted] newsletter and they gave us feedback and they thought it was really useful, but in terms of an international brand it wasn't tremendously huge.

4. Being in a membership Organisation

2a: On the International front we talked to Mass Bio and worked out an agreement with them and now we attend Bio each year. We also have relationships with LyonBiopole, BioTap, and others in Europe. This enhances our membership with companies from these international companies who are in turn members of these international cluster organisations. Just last week we had BioMunich who were over to find out how we work and how we do things. Which means we are well known and respected. Other than those types of activities there's loads of stuff going on.

2a: We created an informal group that we chaired called BioPartners , which includes (UKTI< BIA< One Nucleus and OBN). BioNow was created from a development agency. He came to me . We have 500 plus members between them. They were asking how they go from a regional non-paying organisation to a membership one, charging a membership fee. We discussed what the added value would be and said that they could be part of our purchasing consortium. BioNow emerged about 18 months ago but they don't have an international focus.

2b: Perhaps there is an optimum size for a cluster network to be efficient? When you get too big you're not successful, so at what point should you say OK we can't extend this anymore, we're gonna lose impact.

5. **Measuring success**

2a: We use questionnaires. We inform UKTI and others when we have generated any interest or an outcome.

2a: Members have to decide if they can justify the cost of membership therefore; membership is a good measure of our value. We have different levels of membership including gold, silver and bronze. (MEMO – Depending on the size of the organisation)

2b: We don't hear about what the companies are doing, but we do have Boots in Dundee as they came along to the conference. From a networking point of view..we get people meeting and having conversations that they wouldn't otherwise have.

2b: Our other achievement is lasting that long. We have that corporate memory, although we've had lots of different co-ordinators. That learning has not been lost, so we have continuum. So if Glasgow or Edinburgh were to start up a new network organisation, they would have to get people understanding what the brand is and buying-into –it. That corporate learning has been found not just in the council but in the whole community. To still be seen as worthy and worthwhile by all partners 17 years later

2b: We tried to get information. Because of the ERDF funding we get access to information from [redacted] so if they are helping to commercialise stuff in this area we would have access to understand where [redacted] may have fitted into that. *It's more difficult to do that, but we do know that we need to say and show what our outputs are.. Our outcomes, so saying that several people attended is fine, but what did that actually mean? We are looking at clever ways of doing this, like quotations from people, which kind of the next step really.*

2b: *Some of the social type events like having a BBQ for 100 people I struggle with, but actually the conversations you hear at that BBQ's* money couldn't buy it. We've got clever about the opportunities at the BBQ, we get people to sign up for things, so it's become a more marketing opportunity as well. It's important for us in the council too as we get information from [redacted] about what needed like should we be building more units.

2e: Very successful, [redacted] its heart was a networking organisation, yet when we did that review we were able to demonstrate through interviews with individual people that we were helping to increase the number of people employed

2e: So we had economic drivers eg numbers of FTEs positions created then we had more soft metrics around the number of events and the split between the attendees between the balance between academic vs NHS vs industry, the number of articles, pieces of PR, PR thats been picked up and circulated through a wider press and the number of cases we'd produced.

2e: Yes we did but that was because we had to as it was part of our metric. A lot of the time it was a long process from introduction to actually doing something

6. **The main barriers to success**

2B: [redacted] was very successful at these Bio events and it meant that [redacted] got continually harangued by Edinburgh and Glasgow, but there was nothing to stop them doing it too. They don't take things out for us, but it's wider than that. SDI would take things out for us

2b: [redacted] recognise we've been around for so long now so they don't hassle us anymore, because why would they hassle something that's been successful. If they have a brand that's any better than we can start talking. We have had to work a little harder because it's [redacted].

2b: This is because we're not seen as team Scotland, but we have been successful at promoting ourselves, but we are absolutely team Scotland and that's always been the misunderstanding. If you come up with something better

2b: It works against us that SE are based in Edinburgh and Glasgow. At least when we had LEP you had people batting for us.

2b: : It will be as money gets tighter in the council and that's why it's important to show an impact of [redacted] in a less anecdotal form. We know the cuts will happen and the stuff that we do will be looked at, so yeah funding also remaining relevant talking to people. So there's no point retaining the status quo and not doing anything

2e: The main barriers to success was funding...there was some scepticism on the utility of the network from Edinburgh and the East and how well it could be used. The West of Scotland could see the benefits, but introducing it to Edinburgh was quite a hard sell, so possibly because it was twofold 1) because it came from the West of Scotland, the issue of the inherent East – West divide and 2) People just couldn't see an absolute need for it because there hadn't been something there before. It's like if you try to convince someone of something that really good for them, they kind of won't do it because of the issue of having to get off your backside and do something. The challenge they had in Edinburgh is Edinburgh University is so significant in itself. I think [redacted] had already been started, so they just saw that they didn't need anything else other than themselves so why would they plug into something that would be delivered to them.

2e: We enjoyed a respected position in the community and that was because we didn't have a subscription model. I think when you have a subscription model you get too much buy in from people who are paying for the subscription. The universities will never contribute as much as SMEs collectively and therefore you'll be constantly be working for the customers who are paying for it. Doing what they want as that's what they are paying for

MEMO – barriers to why they didn't go down the subscription path

2e: The universities will never contribute as much as SMEs collectively and therefore you'll be constantly be working for the customers who are paying for it. Doing what they want as that's what they are paying for.

2e: We were able to present this neutral and balanced position where we were in favour of one thing over the other. Cos you'll never get academics who will go into something that's constantly about HR or IP protection you'll only get companies.

2e: They have a procurement deal that allows companies to buy in cheaper for services and reagents/consumables. I know that SE had talked about having a buy-in pool but that was in competition with [redacted] procurement, so as a Govt they were basically setting up in competition with one of your SMEs. This was a bit harsh.

2e: Working locally in Scotland seemed bizarre to me, prior to [redacted] I was connected to people in [redacted] and the EU bio networks and it never dawn on me that I would have to only work in Scotland.

2e: One of the challenges in brokerage has got to be the different players involved in it. It about finding out who does what and where they fit in. So it's ok to speak to a SME but when you come to an academic they are governed by the TTO, so they want to be informed or involved. (MEMO-KEC)

7. **The Expectation Gap**
   Customers

2b: from academia it's about the opportunity for further research and income.

2b: It's all about growing into something bigger, but underneath that its identifying what's need for that, so that can be support in infrastructure it can be lab space, so that's where we would come in. So that's why we work with [redacted] to help them achieve their commercialisation goals.

2e: Yes we had a some key metrics that we had to report to the ERDF and they were reported on a quarterly basis as well as all the associated paperwork that went with those .The expectations from academia were that we would have the quarterly meetings with them and provided them with updates, they wanted to see their work getting the PR and the academics getting the exposure. We very much would take from them what they made available to us , so none of them could really say none of this ...a few times they would say "this is not fair, this university is getting way more exposure than we are at and our counter argument would be at then give us some more stuff'.

2e: Yes we would do anything that anybody gave to us, we would change it to make sure it was targeted right, it was written well and that it had the most impact that it could have, but we never said we would never include it. We might have said we're not going to include it this month because we have a mound of stuff this month that's already very similar and it wouldn't get as much exposure. So academia basically wanted us to broaden awareness and broker collaboration to which we did. The business perspective, we did the same sort of thing. So we did case studies for them, we did PR for them and introductions and the international awareness raising that we did.

Funders

2b: Yes, also early on we wanted to get some commitment, so the Universities of [redacted] and [redacted] all put in an amount of money. We didn't go after the biotech companies as they were all small and the whole purpose of what we were about was to build and create more of them.

MEMO- [redacted] doesn't have a role in spinning out or starting up companies, so I think what is meant here is that they facilitate others to do it

2b: The funders it's about their expectations for jobs and growth.

2e: Yes we got sponsorship from companies like Thermo Fisher, they sponsored a specific Stem Cell event which was to get researchers together who were interested in Stem Cell research getting them together so there could be collaboration with industry and research. So we had those specific interest group in Stem Cell research, and to kick that off we had a big event and involved the Stem Cell network in that too. This was all done as a response to a request from some of the SMEs to work in this area. We had to tread carefully as the feedback was that the SSN was parochial and all based in Edinburgh, however we found the SSN to be quite inclusive. The only challenge I had was they were happy with us doing a special interest Stem Cell group

2e: So we used to get sponsorship for that and we used to get sponsorship for the awards we used to give out, which was brilliant at getting PR and a lot of the younger researchers thought that they were instrumental in raising awareness of the research that they did and two young researchers who won the prize have spun out from the universities.

Government Bodies

2b: The stakeholders have an interest in growth, so from a Govt perspective, from a business perspective it's about growing businesses

2e: From the Govt perspective, if its [redacted] then they expected us to drive economic development as did the ERDF and then we were able to go back and demonstrate the metrics we had in terms of the engagement with the people in our region. Also from the Govt perspective we met with a couple of Govt advisers who would advise Govt in Scotland, on diff issues. It was alongside other networks like [redacted] and BIA.

8. The KEC Activities

2a: I have a presentation in my back pocket that I can pull out if I'm at an Embassy or elsewhere. So I speak on behalf of our members wherever I am.

2b: The overarching one was to grow the LS sector and to affect our economy in a positive way, but underneath that it's about knowledge and skills development, partnerships and collaborations, information exchange, networking. Trying to identify where possible where the opportunities are anything that would create strengths within the sector.

2c: we publicise science etc for school children through the Science centre, it doesn't cost us anything.

2b: New companies come in they always want new stuff, esp if we have new spin-outs they come to everything that they can because they want knowledge and skills. Especially if the sector is calm, you may not get the same attendance, but there's certainly lots of interest in Project Management Training and other things they need for within their companies. The scientist want presentation skills for presenting whatever. We wouldn't do it if there was no take up.

2b: Where we add value is by getting everyone to come along. It lowers the cost across the board and sometimes they get that interaction with the community that they wouldn't otherwise get.

2e: We also did a whole seminar series on IP and patents, which I know we got feedback on from one SME that found it incredibly useful to send their staff to, so that their staff were made aware of when they were developing an innovation. What do they need to do to make sure that innovation was protected and to make sure that knowledge was recounted to clients?

2e: Yes we did, we also produced a newsletter on a quarterly basis, but on top of that we used to circulate PR to press agencies and we had our own contacts in the press. We used to raise awareness of both academic research and businesses too.

2e: So we put on events that were in area that people needed to gain understanding in diff areas, we did pitching and etc and we did targeted KE events a series of 3 of them. Where actually SMEs would stand up and pitch an issue or problem that they had and we would get the whole room to brain storm the problem, so we could help them or put them in touch with someone else we knew, then we would do a kind of bespoke stuff, like an introduction service as well. So we would work with people like Interface in its early days, or its Universities to identify who would help the SMEs

2e: I think in terms of skills and training for early stage and even later stage researchers and helping them to understand the commercialisation process and to help them establish their own networks to take things forward. From the SME perspective it was raising awareness of the opportunities between academia and industry to raise awareness of collaboration and communication between the two.