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LIVERPOOL

Emerging landscape for the management of university knowledge transfer offices: a UK based exploratory study

Thesis submitted in accordance with the requirements of
the University of Liverpool for the degree of Doctor in Philosophy

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February 2010

ABSTRACT

In the era of entrepreneurial university, building and sustaining an effective knowledge transfer office (henceforth KTO) is considered by many as one of the key elements in determining the university's overall success in the knowledge transfer business. However the management of such office is lacking in systematic understanding and remains void in extant literature. This research seeks to fill this void by investigating the managerial issues of university KTOs in the United Kingdom.

In this thesis, research questions were pursued by conducting two empirical studies, each of which provided a different perspective. The first empirical study seeks to identify the patterns of management for university KTOs in the context that universities are in a state of transition from conventional to entrepreneurial. Elements of strategy, process, people, and platform of knowledge transfer office management are the focus of this study. As a result, the study revealed that the management of university KTOs in the UK is also in a process of transition, which exhibits a spectrum of patterns including reactive, responsive, and proactive. Moreover, five general features of KTO management were also identified by the use of Grounded Theory methodology. These features correspond to principles of the open innovation paradigm, hence expanded the university's perspective on its connection and interaction with business and wider communities.

Following the first study, the second empirical study analysed the leading university knowledge transfer practitioners' perceptions regarding university KTO management. Utilizing Q methodology, this study identified four perspectives held by knowledge transfer practitioners. The results of this study revealed the patterns of diverse perceptions of leading technology transfer practitioners and identified their preferences in managing KTOs, which also reflected the findings of first empirical study.

Keywords: university knowledge transfer office, management, cognitive perspective, governance, grounded theory, Q methodology

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ACKNOWLEDGEMENT

As the moment has come to acknowledge and thank those who have supported, inspired and encouraged me, I can only hope that they already know that they have played a significant and meaningful role in my PhD study as well as in my life. Firstly, I would like thank my supervisor, **Dr Hossein Sharifi**, for his earnest, professional and knowledgeable guidance. His willingness to challenge and offer support have made my research more than a final product but a memorable experience and a precious process. Without his generous guidance and help, the completion of this thesis would not have been possible. I also want to express my appreciation to many individuals in the University of Liverpool Management School for their inspirational advice and generous support since the very beginning of my study at the School, including **Professor Dennis Kehoe, Dr. Hossam Ismail, Dr. Andrew Lyons, Dr. Paul Drake, Dr. Zenon Michaelides, Dr. Dotun Adebanjo,** and **Dr. Dong Li.**

I am greatly beholden to financial supports from the Overseas Research Student Award Scheme, and the ESRC and EPSRC research project of Innovation and Productivity Grand Challenge. In the course of the IPGC project, I have received valuable suggestions and assistance from colleagues. However space constraints permit only a few could be named including **Dr. Roula Michaelides, Dr. Pablo D'Este Cukierman, Dr. Markus Perkmann,** and **Dr. Eric Stam.** Moreover, many others deserve my sincere appreciation in making this thesis a reality, including **Brian McCaul, Gillian McFadzean,** and **Ann Craig** for sharing their insights and experiences in university knowledge transfer and offering generous assistance in my connection with the practitioners' network. In addition **Tim Vorley** also facilitated and assistated in the data collection of my research.

Finally but not least, I would like to dedicate my special acknowledgement to my family, in particular my beloved wife, **Ling Wang**, who has been – and still is – giving constant support and encouragement to me during my studies and my life both spiritually and materially. Her diligence, resolution and patience will always be my mightiest impetus and precious treasure.

CHAPTER I. INTRODUCTION

1. Background

Over the past several decades, after the longest period of uninterrupted economic prosperity in modern times, innovation, which is viewed as a key to strategic competitiveness and business success, has experienced a significant and rapid change. Notably this change has been happening against the backdrop where the drivers giving rise to past growth had been changing, meanwhile uncertainty as well as new opportunities in innovation have accordingly been developed (2005; Foray & Lundvall, 1996). The innovation system has been shifting towards a more complex socially distributed structure of knowledge production and dissemination involving, in particular, a wide variety of organizations having distinct goals of exploiting knowledge (OECD, 1999). With respect to the innovation process, Rothwell (1994b) pointed out that innovation had entered its fifth generation which encompasses the high levels of strategic and technological integration between various functions and organisations inside and outside the company's territory. The nature of innovation has also changed significantly as the innovation capability is seen less in terms of the ability to discover new technologies and more in terms of the ability to systematically exploit the outcome generated by innovative combinations and utilization of pieces from the existing knowledge (Chesbrough & Teece, 1996). As such, businesses have broadened their perspective for generating fresh ideas, pioneering new technologies, and promoting entrepreneurship and creativity (Audretsch & Thurik, 2001; Dodgson et al., 2005; European Commission, 2003a). For the purposes of sustaining their competitive advantage, some forward-looking organisations have sought ways to transform the mechanism of innovation in order to create differentiation and sustainable value (Chesbrough, 2003c; Chesbrough & Crowther, 2006). Since the 1970s, innovation has evolved from technology focussed innovation to business model focussed innovation (Chesbrough, 2006a; Chesbrough & Schwartz, 2007). Over the past several years, this initiative led to the popularisation of the new 'open innovation' paradigm (Chesbrough, 2003a). The open innovation paradigm focuses attention on the importance of business' identification as well as usage of ideas and knowledge from outside the boundaries of business (Chesbrough, 2006b). Many different types of initiatives fall under the caption of open innovation: scanning the external environment for ideas, reaching out to a

specialist on a contractor basis to solve a particularly difficult research problem, forming a joint venture, licensing technology from a university, or participating in broad networks to coordinate innovation activity (Hagel & Brown, 2006). Importantly, Chesbrough argued that establishing a close relationship with university is of critical significance for adopting open innovation in business (Andrews, 2003). This accentuates the roles universities are playing in underpinning the business innovation. For instance, empirical research (Cohen, Nelson, & Walsh, 2002; Jaffe, 1989; Mansfield, 1991; Mansfield, 1995) revealed that business innovation has been significantly based on academic research.

Moreover, the government is now considering university as a strategic asset in the knowledge based economy (Mowery & Sampat, 2006; OECD, 2002b). The UK Science and Innovation Investment Framework for the period 2004-14 stated, 'Britain must invest more strongly than in the past in its knowledge base, and translate this knowledge more effectively into business and public service innovation. Securing the growth and continued excellence of the UK's public science and research base will provide the platform for successful innovation by business and public services'(HM Treasury, DTI, & DfES, 2003). Similar sentiments are reported elsewhere, for example, the Sainsbury Report(2007) pointed out that 'creating strong links between Higher Education Institutions and businesses is an essential part of improving our economic performance, and HEIs have an increasingly important role to play in increasing the competitiveness of regional economies'. Moreover, the European Commission (2003b) reviewed the position of university in the knowledge society as 'The knowledge society depends for its growth on the production of new knowledge, its transmission through education and training, its dissemination through information and communication technologies, and on its use through new industrial processes or services. Universities are unique, in that they take part in all these processes, at their core, due to the key role they play in the three fields of research and exploitation of its results, thanks to industrial cooperation and spin-off; education and training, in particular training of researchers; and regional and local development, to which they can contribute significantly'. All these placed the university in the 'central stage' of the national and regional economic development.

Recently, models of knowledge production and diffusion such as 'National Innovation System'(Mowery & Sampat, 2006; OECD, 1999), 'Mode 2' (Gibbons et al., 1994) and 'Triple Helix' (Leydesdorff, 2000; Leydesdorff & Etzkowitz, 1998; Shinn, 2002) have

endorsed the idea of integrating university into the system of innovation, and have also emphasised on the connotation of complexity and significance of university-industry interaction. Against this backdrop, universities have experienced considerable change in the way they operate (Etzkowitz, 2003a; Nelsen, 2001). Universities gradually recognized that they had to respond to proliferating new demands from government, industry and even broad communities, whilst maintaining and improving the traditional missions of research and teaching. As a result, universities are now taking a proactive stance in putting knowledge to use and in broadening the input into the creation of academic knowledge (Godin & Gingras, 2000; Hughes, 2006). Likewise, universities have broadened their vision to serve as a public 'hub' for regional and international stakeholders to exchange ideas and connect with global economy (Hughes, 2006; NESTA, 2007). Etzkowitz (1998) referred to this situation as the 'second academic revolution', in which economic and social development emerged as an essential mission of universities which resulted in the transition of university from the conventional type to the 'entrepreneurial university'(Clark, 1998).

The entrepreneurial university is an emergent phenomenon that is a result of the university's fundamental shift from previous 'inner logic' to embracing wider perspectives (Clark, 1998; Etzkowitz, 2003a). University used to develop its own value system and academics had their own norm of behaviour consistent with the disposition of members in the academic community (Delanty, 2002; Louis & Anderson, 1998). During that time, bringing innovations to market had not been the main role of university-based researchers. Over the last two decades, there has been a considerable shift in the perception of the university's role. This has been primarily due to the changing importance and nature of knowledge in the emerging knowledge based economy but also due to government policies that aim at enhancing international competitiveness in global markets through industrial innovation that has created an expanding demand for which universities are expected to offer (Cohen et al., 2002; Fabrizo, 2006; Jaffe, 1989; Mansfield, 1991; Thursby & Thursby, 2006). By this token, the conventional concepts of academic research, dissemination, and even education are all being redefined resulting in changes, sometimes dramatic but often more incremental, in the organization *per se* and the behaviour of academics. With entrepreneurialization (Clark, 1998; Nelsen, 2001; O'Shea, Allen, Morse, O'Gorman, & Roche, 2007) universities no longer merely serve as the source of technological advances for industry but also proactively engage in the dissemination, diffusion, and deployment of

knowledge through adopting a variety of business models (Etzkowitz, 2003c; Etzkowitz, Webster, Gebhardt, & Terra, 2000). In short, in the 'entrepreneurial' era universities have worked up the boundary spanning structures and mechanisms to interact with the 'outside' world of businesses, communities and government agencies(Clark, 1998; D'Este & Patel, 2007; Etzkowitz, 2003a), have diversified funding base beyond sole reliance on government (HEFCE, SFC, HEFCW, DfEL, & DfIUS, 2007; Hughes, 2006) and more importantly have an integrated entrepreneurial culture to accommodate commercialisation activity and university-business interaction(Clark, 1998).

The significance of university to industry knowledge transfer in the UK had been fully recognized by the mid 1990's after a widespread debate concerning the effectiveness to utilise university research (Grady & Pratt, 2000; Hoorebeek, 2005). In 1993, the UK government White Paper titled 'Realizing Our Potential: A Strategy for Science Engineering and Technology' (Office of Science and Technology, 1993) argued that steps needed to be taken to 'help to harness' strength in science and engineering to wealth creation 'by bringing it into closer and more systematic contact with those responsible for industrial and commercial decisions'. More recently, the Lambert Review(2003) pointed out that '... [In] the UK, where research output from the universities compares well with the international competition, but business research does not. Properly managed, there could be significant opportunities for UK business to sharpen its competitive edge through these new partnerships [with universities]'. Furthermore alongside these policy papers, the UK government has also carried out a variety of initiatives and programmes to enhance university industry links (European Commission & Federal Ministry of Economy and Labour Austria, 2001; OECD, 2001).

In this milieu, university knowledge transfer activities in the UK have proliferated remarkably over the past two decades (Holi, Franklin, Hugo, & Lapinski, 2007; UNICO, 2003; Wright, Birley, & Mosey, 2004a; Wright, Clarysse, Mustar, & Lockett, 2007) in the form of patenting, licensing, consultancy, collaborative research with industry and the creation of spin-off companies. According to the HE-BCI Survey (HEFCE et al., 2007), UK based universities' income from business in consultancy contract has increased 128% from 2001-2002 to 2005-2006, and a report by Library House(Holi et al., 2007) revealed that the total turnover of all active university spin-outs has increased by 240% since 2000-2001. However, in spite of the rapid growth in university industry interactions, the empirical evidence also indicates significant institutional barriers to the

commercialization of university research (Howells, Nedeva, & Georghiou, 1998; Lambert, 2003; OECD, 2001). For instance, Michael Porter's report (Porter & Ketels, 2003) argued that the UK is still relatively poor at commercialising its research and identifies this as a barrier to UK innovation. As a consequence, there is still much space for the improvement of university industry interactions. For example, the recent UK Innovation Survey of 2007 found that only 1% of companies in the UK regarded universities as a source of highly important information for their innovation activities (Robson & Haigh, 2008). A report by DTI(2006) also pointed out that in 2006 UK universities only received £243m from UK's top 850 most R&D active companies which have spent £20bn on R&D.

From an institutional perspective, establishing a specialized knowledge transfer office[1] (henceforth KTO) within the university has been viewed as an instrumental means for facilitating knowledge transfer from university to industry (Howells, 2006; Macho-Stadler, Perez-Castrillo, & Veugelers, 2004; Sampat & Nelson, 1999). For example, a recent report on the state of UK biotechnology identifies a need to strengthen university KTOs if the UK is to become a global leader in biosciences (Bioscience Innovation & Growth Team, 2003). In the UK, since the right to exploit research results through intellectual property was transferred from the British Technology Group to academic institutions, many universities established formal KTOs that introduced a legal formalization and an institutional focal unit for governing the flow of technology from university to industry. In the period between 1984 and 1989 sixty university based industrial liaison offices had been established across the UK(Howells et al., 1998). From the time when British Technology Group was privatised in 1992, most universities in the UK have created formal KTOs (UNICO, 2003). Since then, KTOs have experienced a dramatic change from simple business liaison unit in the university to embrace more functions. In this sense, the evolution of KTOs can be seen as an organizational expression of the change of university's strategies concerning the interactions with industry. As such, driven by the fact that the attention of university

[1] For the purposes of this thesis, the term Knowledge Transfer Office will be used to refer to the university wholly or jointly managed units to facilitate the transfer of knowledge from universities to industry, regardless of their institutional arrangement. Hence in contemporary UK universities, the term KTO may include Liaison Office, Business Support Office, Business Gateway, and importantly Technology Transfer Office which has been widely used in extant literature and public reports.

knowledge transfer has been altered from conventional licensing and patenting (Thursby, Jensen, & Thursby, 2001; Thursby & Thursby, 2007) to the more 'entrepreneurial' (Shane, 2004) creation of spin-out companies (Leitch & Harrison, 2005; Wright et al., 2007; Wright, Vohora, & Lockett, 2004b), KTOs have broadened their role from managing intellectual property portfolio (Thursby & Thursby, 2002) to undertaking a wider spectrum of knowledge transfer activities(Jain & George, 2007; Siegel, Veugelers, & Wright, 2007).

2. Statement of problem

In an OECD report, Tuunainen(2005) argued that 'the traditional university is not being transformed into an entrepreneurial one as straightforwardly as claimed by Henry Etzkowitz' and that it remains an open question whether 'hybrid entities' combining academic work and corporate activity can 'ever survive as stable organizations within a university'. This state of transition caused uncertainty and complexity to the university knowledge transfer. In this situation, the complexity and uncertainty associated with university knowledge transfer has led to concerns over the effectiveness and efficiency of university-industry interactions (Agrawal, 2001; Carlsson & Ann-Charlotte, 2002; Cohen et al., 2002; Debackere & Veugelers, 2005; Feller, Feldman, Bercovitz, & Burton, 2002b; Meyer-Krahmer & Schmoch, 1998; OECD, 2001). While such interaction between universities and industry has gained great enhancement over the past two decades (Molas-Gallart, Salter, Patel, Scott, & Duran, 2002; Siegel, Waldman, Atwater, & Link, 2003a), it is still facing some significant challenges. These challenges include: the need for protecting and promoting university generated ideas and knowledge whist avoiding overprotection of intellectual property and isolation from other stakeholders (Jelinek & Markham, 2007); to improve the efficiency and effectiveness of knowledge transfer to satisfy a broad range of stakeholders' expectations especially considering their distinct clock-speed of decision making (Siegel et al., 2007; Siegel, Waldman, Atwater, & Link, 2004); the need for redefining the channels of knowledge transfer to fit the emerging models of innovation (Perkmann & Walsh, 2007); and to accommodate the variety of models of knowledge transfer to the stakeholders' expectations and university value system (Etzkowitz, Webster, & Healey, 1998). These challenges call for a systematic consideration of mechanisms of university knowledge transfer which is expected to not only coordinate the activities of knowledge transfer, but also mobilize stakeholders and align their interests and strategies concerning university knowledge transfer.

From a systematic perspective, university KTOs can be viewed as the governing body of the knowledge transfer system as KTOs play the role of coordinating the knowledge transfer activities, facilitating information sharing and mobilizing stakeholders engaging in the knowledge transfer business (Etzkowitz, 2006; Leitch & Harrison, 2005; Siegel et al., 2007). By this token, the managerial elements such as strategy, process, and capabilities pertaining to KTOs are believed to be capable of mirroring the working mechanism of the entire knowledge transfer system. Nevertheless, in the situation where the universities are in the state of transition from conventional teaching and research focused towards entrepreneurial universities (Etzkowitz & Webster, 1998; Etzkowitz et al., 2000), KTOs are also experiencing considerable changes accordingly. For instance, in the UK since the termination of the British Technology Group's monopoly in 1992, university KTOs have evolved from the simple business liaison functions to institutions covering a more comprehensive range of activities to embracing most of the university knowledge transfer operations. Such transition has caused uncertainties and complexities in terms of the understanding of the efficiency and effectiveness of KTOs. With around 20 years of development, university KTOs have gained significant recognition as well as equal criticism from university, government and industry grounded mainly on the figures of fact extracted from public surveys(CBI, 2005; HEFCE et al., 2007). For example, most university KTOs in the UK are still not able to cover their costs in comparison to some counterparts in the USA which have gained great financial benefits(Boone, 2006). The Lambert Review(2003) pointed out that 'A barrier to commercialising university intellectual property lies in the variable quality of knowledge transfer offices. Most universities run their own knowledge transfer operations, but only a few have a strong enough research base to be able to build high-quality offices on their own'. The efficient and effective management of KTOs is therefore not only of great significance to the system of knowledge transfer, but also encountering considerable challenges.

KTO is considered by many as the key establishment of university in determining the university's overall success in the knowledge transfer business (Carlsson & Ann-Charlotte, 2002; Chapple, Lockett, Siegel, & Wright, 2005; Lambert, 2003; Thursby & Kemp, 2002). KTO therefore has been under extensive research in many aspects over recent years. Research in this area has covered a wide range of issues such as the rationale of KTO (Macho-Stadler et al., 2004; Sampat & Nelson, 1999), roles KTO is playing in university knowledge transfer (Colyvas et al., 2002; Siegel et al., 2007), and the

productivity of KTO (Siegel, Waldman, & Link, 2003b), etc. In terms of the organization and management issues of KTO, researchers have endeavoured to identify the key KTO characteristics influencing the overall performance of university knowledge transfer, such as the research on organizational structure(Bercovitz, Feldman, Feller, & Burton, 2001), the selection of various commercialization strategies (Bray & Lee, 2000; Meseri & Maital, 2001; Phan & Siegel, 2006), and the KTO staff skills and capabilities (Hertzfeld, Link, & Vonortas, 2006; Jones-Evans, Klofsten, Andersson, & Pandya, 1999). However, the extant research remains relatively fragmented with regard to the managerial aspects of KTOs, that is to say, they have not yet viewed KTO management in a systematic and comprehensive way, and it is therefore difficult to assess the general situation of KTO management to date, which is crucial to achieve an effective and efficient knowledge transfer.

Furthermore, as an important constituent of the management of organization, the cognitive aspect of the management is deemed to be critical in efficiency of organizational management (Barr, Stimpert, & Huff, 1992; Greve, 1998; Kiesler & Sproull, 1982). In particular, the top management team's cognitive bases of management are of great importance in steering and managing the entire organization. In general, two streams of strategy management theory underpin the understanding of top managers' role of strategic decision making in organizations. From the managerial cognition perspective, the information-processing capabilities of senior managers exert significant influence over a variety of organizational phenomena, including strategic decisions (Barr et al., 1992; Stubbart, 1989). Similarly, the 'upper echelons' perspective argues the organization is a reflection of its top managers: 'organizational outcomes – both strategies and effectiveness – are viewed as reflections of the values and cognitive bases of powerful actors in the organization' (Hambrick & Mason, 1984). These assertions are rooted in the observation that senior managers interpret issues relevant to strategic decision-making and possess the power necessary for implementing choices derived from those interpretations (Hambrick & Mason, 1984). With regard to KTOs, serving as the core management team of KTOs, the leading practitioners not only serve as the cadre in providing professional services for stakeholders but also have influence over the strategic decision making of university knowledge transfer. As such, leading practitioners' perceptions and attitudes towards the management issues of KTOs are particularly critical to the efficiency and effectiveness of the university knowledge transfer activities. Nevertheless, the understanding of the practitioners' perceptions

remains void in existing research. Moreover, as both university knowledge transfer system and KTOs are in the state of transition, the management of KTOs as well as knowledge transfer activities have become fairly complex and uncertain. In this situation, practitioners ought to avoid the pitfall of over reliance upon simplistic analyses and take into consideration the complexity and uncertainty associated with the KTOs management. It is therefore crucial to examine the pattern of cognitive perception of university KTOs' leading practitioners.

3. Research questions and purposes of research

This research intends to address the above problems by seeking answers for the following questions:

1) What are the patterns of management for university KTOs? As the university KTO management covers a wider range of issues such as strategy, performance measurement, process management, organizational capabilities etc, this study will firstly resort to existing literature to identify the critical managerial elements related to and of interests to stakeholders in the context of the entrepreneurial university. Secondly, based on the identification of critical managerial areas this study will reveal the landscape of KTO management and explore the characteristics of KTO management. This study will present the characteristics of entrepreneurial university from an angle different from those suggested by Clark (1998) – the proposed characteristics will be analyzed through the lens of emerging innovation theories and in particular the open innovation paradigm.

2) How do university knowledge transfer professionals and practitioners perceive the university knowledge transfer management? This study intends to reveal the patterns of leading knowledge transfer practitioners' perceptions concerning the landscape of KTO management revealed by addressing the first research question mentioned above. Therefore questions to be asked include: what are the patterns of leading practitioners' perceptions concerning the management of KTOs? What are the practitioners' concerns and preferences towards the KTO management? And what is the consensus of leading practitioners in managing KTOs in the context of the entrepreneurial university?

4. Research framework

In line with research questions proposed in previous section, this research is comprised of one theoretical study and two empirical studies shown as **Figure 1**. This research starts from the theoretical study on KTO related issues in the form of reviewing extant literature. The purposes of literature review are not only to explain the theoretical underpinnings of this research and to assist in identifying the void in the extant literature which this research is designed to fill, but also to offer resources for later investigations and support the comparison of results from empirical study with those learned from theories. Major topics in this section include the review of the ecosystem of university-industry interactions, the characteristics of university knowledge transfer, the development of KTO, the position and role of KTO, and in particular, the managerial issues of KTO.

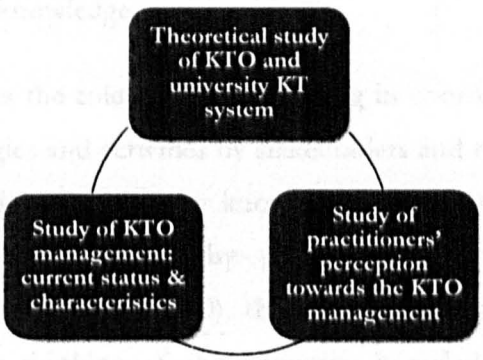


Figure 1 Research framework

Based on the theoretical study, this research diverges into two interrelated empirical studies, i.e. the study of current KTO management in the UK universities, and the study of perceptions of leading practitioners within KTOs which reflect upon and connect with each other closely. Considering the 'exploratory' nature of this research, the empirical studies have employed Grounded Theory and Q Methodology both of which are categorized as qualitative research methodologies reflecting their interpretivist characteristics (Brown, 1996; Strauss & Corbin, 1994). In the first section, the empirical study adopted a multiple case study method as the instrument for the research in which 23 university KTOs across the UK were visited and leading practitioners were interviewed. In the Q methodology based study, a Q survey was conducted across 80 universities in the UK and followed by a number of short interviews with survey participants.

5. Significance of the research

In the book titled 'Pasteur's Quadrant: Basic Science and Technological Innovation', David Stoke (1997) developed a taxonomy of research by reviewing the history of general science and particularly Louis Pasteur's contribution. In his suggested 'Pasteur's Quadrant', research is categorized as to whether it is conducted in a quest for fundamental understanding or whether it is motivated by considerations of use. Seen from this angle this research is designed to cover both the issue of meeting practical needs as well as presenting a rigorous understanding of the subject and mechanisms of university knowledge transfer to be valued by at least two clusters of stakeholders. Considering the nature of this research and methodologies employed, the significance of this research rests on two main categories: the practice aspect including influence on policy makers and knowledge transfer practitioners, and the research aspect, namely the contribution to academic knowledge.

Firstly, this research values the role KTOs are playing in coordinating and aligning the knowledge transfer strategies and activities by stakeholders and redefines the position of KTOs from the perspective of university knowledge transfer system. Considering the current polycentric strategy adopted by governments in supporting university knowledge transfer (Grady & Pratt, 2000), this research could offer policy makers a perspective on systematic thinking of the university knowledge transfer system that covers a broad spectrum of stakeholders. Moreover the research argues that some existing criticism on KTOs should be attributed to the faults on the side of the knowledge transfer system. Therefore both government and university management should view the value and position of KTO from a systematic perspective.

For practitioners, this research has two main points of value. On one hand, this research provides a systematic analysis of the key areas of KTO management which could be used as a diagnostic tool for practitioners in managing the KTOs' strategy and processes. Additionally, the characteristics of KTO management summarised in this research could inspire practitioners on knowledge transfer strategies such as the strategy on intellectual property portfolio management and new performance measurement systems. On the other hand, by mapping perceptions of practitioners this research broadens the practitioners' perspective of KTO management, in particular in the context of the emergence of new innovation theories and paradigms.

With regard to the academic audience this research fills the void in the extant literature in relation with study of KTOs' management. The research sets out to treat KTOs not merely as a peripheral setup by universities but take into consideration their broader roles within the entire university knowledge transfer system. Likewise, by proposing the study framework of KTO management and the university knowledge transfer governance system, this research offers a systematic perspective on the existing research of this subject. Additionally this study highlights the management issues of KTO which are traditionally not recognized by researchers in the area of university-industry links. In terms of research methodology this research is introducing Q methodology to the area of the research on university knowledge transfer which acknowledges the importance of the cognitive aspect of university knowledge transfer.

6. Plan of the thesis

In line with the procedure of conducting this research, the thesis is organized into three sections as follows. The first section aims to draw a map of the phenomenon of interest, identify the purposes of the research and design the methodology of the research. This section includes **Chapter 1** as introduction, **Chapter 2** as literature review and **Chapter 3** as methodology. In the introduction chapter the general background, statement of problem and research questions are presented and more importantly, the framework of the research is proposed to outline the entire thesis. The literature review chapter provides an extensive review of the history of university knowledge transfer in the UK, key environmental elements of university technology, features of university knowledge transfer, the emergence and development of KTO, and the main managerial issues in relation to KTO. This chapter not only presents the theoretical thinking rooted in the existing literature of university knowledge transfer and KTO, but also intends to identify the critical areas of KTO management that the following empirical study is focused on. The literature review also takes a critical approach to analyse the situation in the world of university knowledge transfer and identify the existing context, which leads to a classification of factors determining the status of university knowledge transfer in terms of increasing uncertainty and complexity. The methodology chapter contains the introduction to the characteristics of the research and the analysis on two major methodologies used in the study, namely Grounded Theory and Q methodology.

The second section presents the main empirical investigation of the thesis. This section covers two studies which form the main body of the thesis. The first one, which is

displayed in **Chapter 4** and **Chapter 5**, presents a multiple-case study of 23 KTOs within universities across the UK. In this chapter the study engages in mapping the current managerial situation of university KTOs across the UK. Based on cross-case comparison the study revealed a spectrum of styles of KTOs management, which reflects the present status of the transition state of entrepreneurial university. By analyzing the managerial spectrum of KTOs, this chapter also explores the characteristics of KTO management which mirror the features of the university knowledge transfer system. The second study covered in the second section is the Q study detailed in **Chapter 6** which focuses on practitioners' perceptions of critical management areas as well as the identified characteristics of KTO management. The Q methodology based study follows the initial empirical study by utilising the findings of the empirical study to examine practitioners' perceptions on management of university knowledge transfer. The last section covers the discussion and conclusion of research, which are included in **Chapter 7**. In this chapter, conclusions of the research are drawn by integrating research results from both theoretical and empirical studies. In addition, several implications of the research are discussed, in particular with respect to the system view of university knowledge transfer. Following this, further areas of research and limitations of research are presented.

7. Summary

Since the 1970s universities have encountered increasing challenges resulting from fast business innovation development and government policy changes. In response to these challenges, universities have broadened their perspective to embrace a wider spectrum of business models to meet new demands from a variety of stakeholders. This situation resulted in increased complexity of university knowledge transfer system. Within the university knowledge transfer system KTOs are known for playing a critical role in facilitating university industry interactions, and efficiency and impact of which have become major concerns for research, practice and policy. Improving the efficiency and effectiveness of KTO management could significantly enhance university knowledge transfer. However the management aspect of KTOs remains void in extant research and is not viewed in a systematic way. This research intends to fill this gap by conducting an extensive theoretical and empirical study in the management of KTOs including investigation of characteristics of KTO management and mapping the perceptions by leading practitioners towards the management issues. This chapter also briefly reviewed

the environmental factors of KTO management and pointed out the research problems, and defined the research questions. The cognitive framework of the study has also been presented followed by an analysis of significance of the research.

CHAPTER II. LITERATURE REVIEW

1. Introduction

This chapter aims to review the extant literature for building the theoretical and contextual framework in which this research is embedded. Albeit the general purpose of literature review is to gain an understanding of the current state of knowledge regarding the targeted research, the literature review usually plays several further critical roles in social science research. According to Johnson et al (2007, p3), the literature review 'can be used to explain the theoretical underpinnings of the research, to assist in formulation of the research question and selection of the study population, or to stimulate new insights and concepts throughout the study'. By the same token, the purpose of this literature review accordingly has three facets, namely, providing theoretical background for the research, identifying the gaps existing in extant literature, and offering a critical view to pursue insight into university knowledge transfer.

For the purpose of offering an explicit and comprehensive view of conceptual and empirical issues in relevance to the topic of this research over time, mainly regarding university knowledge transfer and university knowledge transfer office, this research applied a three stage exploration process. For initial access to the literature, this research studied recent published special issues of journals in the field of entrepreneurial university and university knowledge transfer. Particularly, this research also identified several comprehensive literature review papers including the papers by O'Shea et al(2004), Phan and Siegel(2006), as well as a recent paper by Rothaermel et al(2007). These special issues and papers provide an immediate and accessible entry into the literature regarding university knowledge transfer, entrepreneurial university, as well as knowledge transfer offices. And more importantly, they assist to identify influential authors and journals in this domain. Next, for the purpose of reducing the source bias in literature survey, by resorting to the electronic databases retrieval service, mainly MetaLib® and Web of Science®, papers previously published in a diverse set of academic journals are collected and indexed by keywords and name of authors. In addition to the academic papers, for the purpose of affording this research with an image of the contextual background, the public reports were also counted, which include mainly the reports by OECD, European Commission and the UK government. In the last stage, the thesis analyzed the collected papers and indentified the key areas of

extant research by 'coding' towards the research questions stated in **Chapter 1**, which assists in categorizing papers in the light of the aforementioned purposes of this literature review. Besides, for the purpose of facilitating the literature collection and analysis, the software of Endnote® is adopted to retrieve reference information from online databases and store collected references. In the same way, notations against articles (say, comments, relevance and issues arising, etc) were made into the Endnote's 'notes' field. These were then used in preparing draft chapters around major conceptual and empirical issues that are believed to be of relevance to this thesis.

In line with the purposes of the literature review mentioned above, this chapter is organized in three sections: 1) the ecosystem of university knowledge transfer, 2) main issues of current research on university knowledge transfer, and 3) summary of features of university knowledge transfer. The first section analyzes the evolution, features and underpinning theories of the ecosystem pertaining to university knowledge transfer. This section covers four major areas favouring the understanding of university knowledge transfer ecosystem: The first part traces the development of the science-industry relationships that have strong influence on the government policy to support university knowledge transfer. The analysis on the science technology relationship also delineates the rationales underpinning university-industry knowledge transfer and demonstrates the complexities and dynamics related to university industry interaction. The second part of this section is centred on the mainstream research on the university's position in the system of innovation, which includes strategic knowledge production and dissemination models such as 'National Innovation System'(Lundvall, 1992; OECD, 1999), 'Mode 2'(Gibbons et al., 1994) and 'Triple Helix'(Etzkowitz, 2003b) etc. In this part, the understanding over the stakeholders' positions in the innovation system is viewed as the focal point of analysis. Following that, the third part reviews milestones of government policy for university knowledge transfer. Within this part the evolution and reorientation of UK government policy is the main focus of the review, and more importantly government policy is understood as the central impetus of university's interests towards commercialization of technology in the UK. The fourth part takes into account the emerging innovation theories and paradigms, including the open innovation and the fifth generation of innovation, which reflects business' demands and proactive strategies towards university knowledge.

The second section of this chapter includes five parts covering the extant streams of research concerning university knowledge transfers. This section starts from the review of literature regarding understanding of the development of the entrepreneurial university over the past several decades, which have dramatically changed the way that university is operating. The development of the entrepreneurial university also mirrors the evolution of university's strategy and operations in response to the contextual changes. In the second part of this section, the focus is placed on the general connotation of knowledge transfer, in which the extant research on the diffusion of knowledge, the meaning of knowledge transfer and its development are included. Following this, the third part of this section describes in detail processes and channels of university knowledge transfer, which covers vertically the spectrum of channels of knowledge transfer, and horizontally the decision making steps pertaining to channels of knowledge transfer which KTOs and faculty are following when they determine to transfer the university developed technology outside the boundary of university. In this part, the knowledge value chain is adopted as the means to underpin the analysis of knowledge transfer processes. In parallel, the fourth part involves issues in relation to the organizational aspect of university knowledge transfer. Certainly intermediaries of knowledge transfer, in particular the KTOs, are the focus of this part within which rationales, roles and characteristics are discussed. Lastly, what previous streams of research have in common indicates the issue about performance of knowledge transfer is of importance to stakeholders. This includes the effectiveness and efficiency of university knowledge transfer which will be explained in detail as the fourth part of this section.

Based on the previous reviews, the last section of this chapter explores the characteristics of university knowledge transfer including multiplicity, dynamics and complexity. This section can be seen as a further reflection and analytical summarisation of previous literature review, and underpins the design and implementation of conducted studies. The general structure of literature reviewed is illustrated by **Figure 2.**

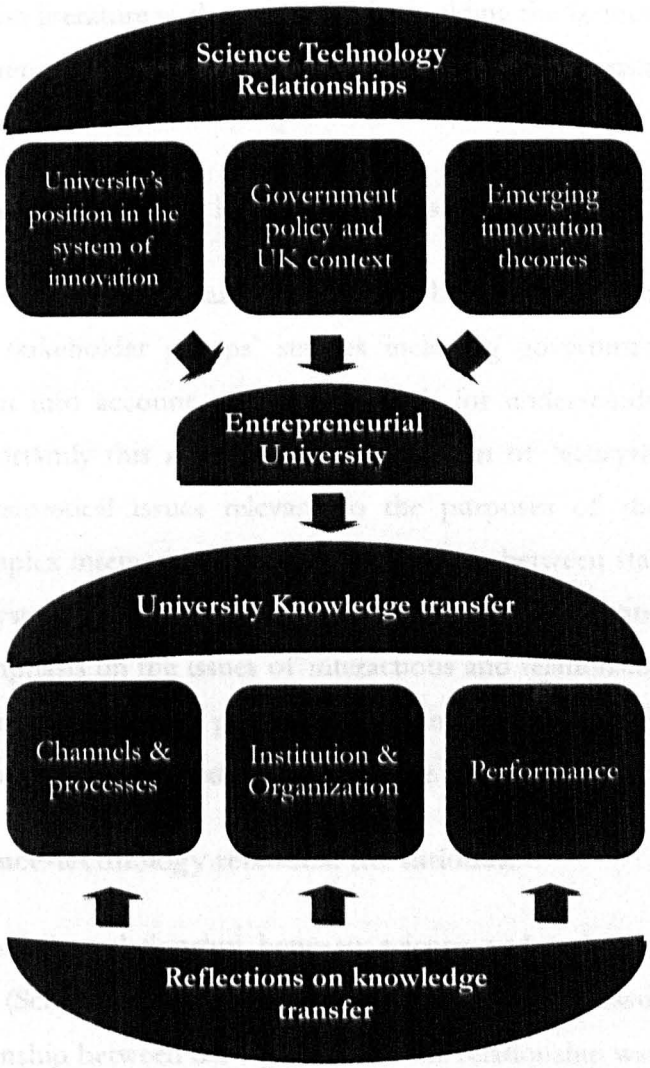


Figure 2 Structure of literature review

Additionally, it is noteworthy that in regards to the qualitative research, the literature review is often integrated throughout the entire study, that is, in the course of the research researchers constantly work back and forth between the literature and the completion of the research (LeCompte, Preissle, & Tesch, 1993). As such, in the grounded theory based study of this research, the literature review serves as the main mechanism to provide theoretical perspective for the research(Partington, 2002) and accordingly to supply the material for analytical comparison (Strauss & Corbin, 1990). Regarding another empirical study of this research – the Q methodology based study of this research – the literature review offers resources for designing the statements needed for the survey and contributes to interpret the results of the analysis(Brown, 1996). Accordingly the literature review in this chapter is a general review showing the contextual and theoretical framework of the entire research, while in each empirical

study and discussion literature is also reviewed for building the framework of each study, assisting the theoretical sampling, and fulfilling the needs for constant comparison in each empirical study.

2. The ecosystem of university knowledge transfer

This section presents the contextual and theoretical background of this research, within which three key stakeholder groups' stances including government, university, and business, are taken into account as the framework for understanding the contextual background. Importantly this research adopts the term of 'ecosystem' in delineating contextual and theoretical issues relevant to the purposes of the research, which highlights the complex interactions and interdependence between stakeholders who are involved in the system of knowledge transfer. As such, the literature review of this research places emphasis on the issues of interactions and relationships. The ecosystem concept offers this thesis with the primary understanding and contextual framework of research into the university knowledge transfer office management.

2.1. The science-technology relations: the rationale

The speculation of the relationship between science and technology dates back to around the 1930s (Schumpeter, 1939, 1989), when it was widely assumed not only that there was a relationship between the two, but that the relationship was linear and causal. That meant that innovation starts from basic research, is followed by applied research and development, and ends with diffusion(Godin, 2005; Rothwell, 1994b). This was understood as the linear 'push' process. Perceptions of effectiveness of science and technology interactions in the Second World War reinforced the supposed validity of this "science push" model (Volti, 2001). It is therefore not surprising that it was this linear model which underpinned the renowned Vannevar Bush's report (Bush, 1945) to President Truman in 1945(Godin, 2005) – having witnessed the importance of university research to the national defence for its role in the successful Manhattan Project, in the report titled 'Science: The Endless Frontier'(Bush, 1945). Bush laid out a blueprint for the growth and development of United States' scientific enterprise, and proposed an intensive effort to advance technology in the service of the national policy and welfare of United States, which has been claimed as one of the most influential determinants in shaping the science policies by government to support the basic research for many decades (Bremer, 1998; Etzkowitz, 2002a; Sampat, 2006).

According to Godin (2005), the linear model historically is 'one of the first frameworks' for understanding science and technology interaction. This model had been predominant between 1950s and 1980s, which is mainly grounded on the common comprehension of the process of innovation based on the legacy of classical and neoclassical economic theorists (Freeman, 1994; Kline & Rosenberg, 1986). However, along with the development of innovation practice, the legitimacy of the linear model has long been questioned by researchers and industry practitioners who became aware that the nature of relationship between science and technology is far more complicated and unpredictable than that proposed by the linear model. Likewise the relationship is much more than the "science push" model which was prevalent during 1950s and 1960s (Rothwell, 1994b). For instance, Schmookler (1966) has explicitly pointed out that the innovation process does not follow the linear model. Similarly, Narin et al (1997) also argued that the linear model is 'too simplistic and highly inaccurate'. It was widely acknowledged that the science and technology relationship is seldom smooth or linear but complex and diversified(Pavitt, 2005; Rogers, 1995). Consequently, there is a need to develop an in-depth understanding of complex interactions and co-evolution of science and technology along different stages of innovation. In response to this situation, several theoretical models have emerged, among which the 'chain-link model' proposed by Kline and Rosenberg (1986) is one of the most preferred models by researchers as it is able to represent the interactions between innovation and market demand. The model delineates a process by which new knowledge is generated and effectively transferred to the organizations that have the potential to commercialize it. By suggesting this chain-link model, Kline emphasizes the socio-technical nature of science and technology and the necessity to look at it as a complex system. The chain-link model differs from the linear model in a number of ways: there are multiple paths from which innovations may arise and many forms of feedback are provisioned. Research is not normally considered to be the initiating step (in fact, research occurs in and contributes to all stages in the innovation process), and the primary source of innovation is now held to be stored knowledge and technological paradigms (Kline, 1991; Kline & Rosenberg, 1986; Smith, 2005). Apart from the chain-link model, there exist some other in-depth views regarding the science technology relationships (Gibbons et al., 1994; OECD, 1999; Rogers, 1995; Ziman, 1991). Gomory(1989), a former senior vice president for science and technology at IBM, developed a circle model of technology development. He summarized paradigms of innovation as the 'ladder' model and the

'cyclic' model respectively. In terms of the ladder paradigm, he argued that technology development descends from the realm of science – 'step by step' – into practice and becomes the genesis of an industry, while with respect to the cyclic paradigm, the science and technology interaction behaves as a process of repeated, continuous, incremental improvement which departs from the legacy science push model. Additionally, in terms of science technology relationship, he stressed that 'university people shouldn't be expected to push their findings into the product cycle. It is the responsibility of the company to pull knowledge into the process when it is needed'. Furthermore, in the research of '5th generation of innovation', Rothwell (1994b) suggested that over the last two decades, science and technology have become more intertwined, and the interaction between the two is characterized by networking, flexibility and integration.

Notably, although some researchers view science and technology as separate streams of knowledge which flow through time independently(Bode, 1965), more recently it has become evident that science and technology have been effectively interacting and advancing with each other. As such the interaction between science and technology has gone both ways (Volti, 2001). According to Volti (2001), on the one hand, science knowledge has been applied to improve and even predict technologies. This is what most people mean when they speak of the interaction between science and technology, i.e. the flow has been made from science to technology. On the other hand, the flow has also gone from technology to science. It has frequently happened when technology has made better instruments that profoundly affect scientific theories, or has discovered new methods that challenge scientists for new theories to explain what happened. Such characteristics of science and technology interaction also reflect the business' propensity of opening their innovation processes and resorting to external sources (Chesbrough, 2003a; Faulkner, 1994). For instance, recent studies (Cohen et al., 2002; Jaffe, 1989; Mansfield, 1991; Mansfield, 1995) revealed that business technological improvement has been significantly based on academic research. Importantly, the interactions between science and technology have underpinned the emergence of the language of 'knowledge transfer', which has made the attempts to bridge the institutional gap between the two regimes(Bremer, 1998; Gibbons et al., 1994).

The relationship between science and technology is complicated and may vary depending on the historical period in question (Gardner, 1994; Volti, 2001), the level of

development of individual industries and disciplines etc (Gomory, 1989), as well as the individual's view of what constitutes technological development (Gibbons et al., 1994; Verspagen, 2006). Such ambiguity may cause puzzlement to policy-makers, who would prefer to work with a widely-accepted model for the interaction between science and technology. It has been suggested, therefore, that since neither model is sufficiently developed as to indicate whether funding science or funding technology will be the most productive and effective path, public policy should be directed towards keeping open the communication between the two(Harvey, 1992). Recent policy development of advanced industrial countries towards the science and technology (European Commission & Federal Ministry of Economy and Labour Austria, 2001; Lambert, 2003) reflects such speculation, that is, the government places emphasis on enhancing the communications and interactions between science and technology.

2.2. University's position in the system of knowledge production and diffusion

Whatever the sources of technological change, researchers believe that there is a causal relationship between technological change and economic growth (Adams, Clemmons, & Stephan, 2004; Faulkner, 1994; Freeman, 1994; Verspagen, 2006). As early as 1930s some political economists, most notably Schumpeter, argued that the process of technological advances is the central impetus to the economies not just for particular industries but for the entire nation(Schumpeter, 1939). For instance, research indicate that since the beginning of the industrial revolution, prolonged periods of economic growth and high employment have been associated with clusters of interrelated technological innovations of considerable novelty (Saviotti & Metcalfe, 1984). Moreover, recent theoretical and empirical research in economics also suggests that the use of scientific knowledge by setting up and maintaining good industry-university relations can positively affect innovation performance (Adams et al., 2004; Feller, Ailes, & Roessner, 2002a; Mansfield, 1991; Mansfield, 1995; OECD, 2002a). Universities are therefore increasingly viewed as pivotal players in the success of innovation and economic development (Feldman & Desrochers, 2003; Mowery & Sampat, 2006; OECD, 1999; Shinn, 2002). Over the last two decades, inspired by the experience of the US in particular, policymakers, business and academics throughout the industrialised world have paid increasing attention to the role of universities as drivers of innovation. Universities and other higher education institutions across the developed countries have

been facing grand changes during the last several decades (Clark, 1998; Etzkowitz et al., 2000; Louis & Anderson, 1998), particularly concerning their roles and positions in the systems of innovation.

The most striking feature of knowledge transfer is that for most members involved in the knowledge transfer, the decision making regarding knowledge transfer depends heavily on decisions by the other members of the system(Edquist, 1997), therefore universities' position and roles cannot be analyzed in isolation from other members of the innovation system (Mowery & Sampat, 2006). In this sense, the system thinking and systematic approach are of significant value to the comprehension of the universities' role for the innovation. In late 1980s, the National Innovation System(Freeman, 1995; Lundvall, 1992; OECD, 1999) emerged in the science policy research literature as the 'first systematic approach' to analyze interactions and relationships pertaining to innovation since the linear model of innovation(Edquist, 1997; Freeman, 1995; Godin, 2007), which 'offers new rationales and new approaches for government technology policies'(OECD, 1997).

Generally, although lacking of a precise definition, among a host of definitions the National Innovation System is given (OECD, 1997) two 'broad' versions (Feinson, 2003; OECD, 1999) of them are believed to represent the idea: one is given by Lundvall(1992) as the 'elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state', and another is presented by Metcalfe(1995) with a more explicit expression as 'set of institutions that jointly and individually contribute to the development and diffusion of new technologies, these institutions provide the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store, and transfer the knowledge, skills, and artefacts which define new technologies'. These definitions recognize the wide diversity of institutions involved in the innovation activities, and emphasize the significance of relationships and interactions existing in the innovation system.

Although the National Innovation System perspective has the implication that the business ought to take the focal role in the system of innovation, it still stresses the university's salient role in the innovation, for instance, the National Innovation System approach has centred on four types of knowledge flows(OECD, 1997): 1) interactions

among enterprises, primarily joint research activities and other technical collaborations; 2) interactions among enterprises, universities and public research institutes, including joint research, co-patenting, co-publications and more informal linkages; 3) diffusion of knowledge and technology to enterprises including industry adoption rates for new technologies and diffusion through machinery and equipment; and 4) personnel mobility, focusing on the movement of technical personnel within and between the public and private sectors. Correspondingly since 1980s, it has been witnessed that universities have been playing multiple roles in these knowledge flows. Especially universities have diverse impacts on innovation(Cohen et al., 2002). For instance, Hughes(2006) has summarised the universities' role in four types namely: education, research, problem solving and providing public spaces for businesses. Universities therefore have been placed in the centre stage of the innovation system. And the work of Pavitt showed the importance of university as a source of (1) skills (particularly those based on tacit knowledge) required to translate knowledge into practice, (2) an enhanced ability to solve complex technological problems, and (3) the 'entry ticket' to the world's stock of knowledge, providing the ability to participate effectively in networks and to absorb and exploit the resulting knowledge and skills(Pavitt, 2002). By the same token, the OECD report(1997, p9) also states that 'The quality of the public research infrastructure and its links to industry may be one of the most important national assets for supporting innovation'.

Moreover considering that from the systemic perspective of innovation, the rate of technical change and of economic growth depend more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as on technical innovations(Freeman, 1995), the universities' increasing salient role in diffusion of knowledge, known as the 'third mission', has been recognized and endorsed by governments and business, which also can be reflected by governments' policies regarding the university knowledge transfer (European Commission & Federal Ministry of Economy and Labour Austria, 2001; Lord Sainsbury of Turville, 2007; Mowery, Nelson, B.N. Sampat, & Ziedonis, 2004; OECD, 2001). In the meanwhile, the National Innovation System perspective also underlines the importance of dynamic relationships among members of the innovation system, as Lundvall argues that 'innovation systems are both social and dynamic'(Lundvall, 2000). Accordingly the business innovation evolution can also strongly influence other innovation system members' strategies and activities towards their innovation, which is observable in the scenario of govern ents'

and universities' response to the 'open innovation' paradigm where business' focus have shifted from technology innovation to business model innovation (Chesbrough, 2006a; Fabrizo, 2006; Library House, 2006).

Furthermore, new knowledge production models also assist understanding universities' critical roles for the innovation. In the book titled 'New Production of Knowledge' (Gibbons et al., 1994), Gibbons et al argued that the way in which scientific knowledge, technical practices, industry, education and society at large are organized and function nowadays grounds on a sharp contrast with the relationships in earlier times(Shinn, 2002). The book presents two distinct modes of knowledge production: 'Mode 1', the legacy paradigm of scientific discovery, and Mode 2, the model mirrors the emergent phenomena and trends of knowledge production. 'Mode 1' is characterized by a cleavage between academia and society, with which, academia revolves around an autonomous university, self-defined and self-sustained scientific disciplines and specialties, and the determination by scientific peers of what does and does not constitute science and truth. In this regard, there is allegedly no interaction between academia and industry. By contrast, 'Mode 2' knowledge production perceives the weakening or collapse of the modern university, the disappearance of scientific disciplines and the atrophy of peer control over the direction and content of research programmes (Gibbons et al., 1994; Nowotny, Scott, & Gibbons, 2003; Shinn, 2002). In 'Mode 2', the knowledge production is characterized by interdisciplinarity, by the fluent movement of short-term task-force teams of experts to problem domains, and by the primacy of social and economic problems in establishing what spheres of knowledge should be developed, as in the book(Gibbons et al., 1994) they argued Mode 2 knowledge is 'carried out in the context of application'. The innovation community thus discarded the legitimacy of science's prerogatives, its institutional autonomy and cultural identity, which reflects new innovation context that university's strategy is facing (Etzkowitz et al., 1998; Nowotny, Scott, & Gibbons, 2001). This situation is explained by Nowotny et al (Nowotny et al., 2003) in their further thinking regarding the model of 'Mode 2' as 1) the 'steering' of research priorities, 2) the commercialization of research, and 3) the accountability of science. In addition, from the government perspective, Mode 2 also indicates that science and technology policies and innovation policies can no longer be regarded as functionally separate, which has been reflected in many countries' innovation strategies(HM Treasury et al., 2003).

Furthermore, Mode 2 also indicates the development of university *per se*, as it highlights the potential re-configuration of institutions that flowed from the wider distribution and greater reflexivity of knowledge production (Gibbons et al., 1994, chapter 6; Nowotny et al., 2003), which reflects the multifunctionality, and particularly, the entrepreneurialization of universities in developing their 'third stream' activities. From the Mode 2 perspective 'knowledge' is now regarded not merely as a public good but rather as 'intellectual property', which is produced, accumulated, and traded like other goods and services in the knowledge economy (Gibbons et al., 1994, chapter 2; Nowotny et al., 2003). Accordingly in the process of innovation, a new language has been invented -- the language of application, relevance, contextualization, reach-out, knowledge transfer, and knowledge management(Nowotny et al., 2003). In this context, especially as the public funding of research has become less adequate, researchers have increasingly turned to alternative sources of funding, and universities and HEIs have become more aware of the value of the 'intellectual property' generated by their research, universities and other HEIs have become more proactive in the knowledge diffusion and also embrace some new challenges. In addition, the Mode 2 characterizes commercialization as a 'force for change' to scientific autonomy, and as the means by which research is revitalized in both priorities and uses, and in the resources it commands. For instance, in the UK, Research Councils and RAE panels now include 'user' representatives alongside more traditional scientific peers.

One of the most influential theoretical developments in depicting the universities' role in the system of innovation is Henry Etzkowitz's conceptualization of the 'science industry government' relationship as a 'Triple Helix', which has embraced and sought to explain a new research paradigm(Etzkowitz, 2003b). According to Etzkowitz(2003b) the Triple Helix is a spiral model of innovation that 'captures multiple reciprocal relationships at different points in the process of knowledge capitalization', which denotes a transformation in the relationship among university, industry and government as well as within each of these institutions, that is, institutions increasingly 'take the role of the others' and the conventional functions of institutions are superseded(Etzkowitz et al., 2000). Triple Helix stresses historical continuities, i.e. previous relations between the university, industry and government persist (Etzkowitz, 2003b; Etzkowitz & Webster, 1998). The Triple Helix model has been delineated in three stages(Leydesdorff & Etzkowitz, 1998), namely, Triple Helix I, II and III. In the Triple Helix I, the three spheres are defined institutionally i.e. university, industry, and government. Interaction

across defended boundaries is mediated by organizations such as industrial liaison and knowledge transfer offices. In Triple Helix II the helices are defined as different communication systems consisting of the operation of markets, technological innovations, and control at the interfaces(Etzkowitz & Leydesdorff, 1997). The interfaces among these different functions operate in a distributed mode that produce potentially new forms of communication as in a sustained knowledge transfer interface or in the case of patent legislation. In Triple Helix III the institutional spheres of university, industry, and government, in addition to performing their traditional functions, each assume the roles of the others, with universities creating an industrial penumbra, or performing a quasi-governmental role as a regional or local innovation organizer (Etzkowitz, 2003b; Leydesdorff & Etzkowitz, 1998). The growing role of the university in the new economy goes well beyond providing industry and the state apparatuses with trained personnel and engaging in research that provides a knowledge base for industry to draw upon. In this sense, the Triple Helix model emphasizes that universities can play an enhanced and broader role in innovation, comparing to conventional relations between the university, industry and government in the early time (Etzkowitz & Leydesdorff, 2000).

The Triple Helix model also has several implications which are believed to be of importance in depicting the development of university knowledge transfer. Firstly, as Leydesdorff and Etzkowitz (1998) argued that the institutionally defined Triple Helix is premised upon separate academic, industrial, and governmental spheres and the 'knowledge flows' among them. In this regard, knowledge transfer is no longer considered as a linear process from an origin to an application, rather is understood as a recursive model which underpins the dynamics of the university knowledge transfer(Etzkowitz, 2002b, 2003b). Secondly, in the Triple Helix model, the organizational mechanisms are sometimes extensions of conventional technology licensing offices which act as intermediaries between the universities and existing firms. These new arrangements may be tied directly to the research and teaching activities of the university and extend these in the direction of industrial innovation(Leydesdorff & Etzkowitz, 1998). Thirdly, the Triple Helix is a thesis of 'the more the more', rather than one institution depletion, that it to say, in the Triple Helix, it is possible that one institution plays multiple roles without its original role is degraded or harmed(Etzkowitz, 2003b). Lastly, the Triple Helix regime offers a platform of 'institutional formation', that is to say, the creation of new organizational formats to promote innovation(Etzkowitz,

2006), such as incubator, science park, and more importantly, the new development of knowledge transfer offices which is the main topic of this thesis.

2.3. UK government's policy concerning the university knowledge transfer

The government plays the most crucial role in promoting university in the centre stage of the innovation system. As Etzkowitz (2003b) argues government not only is 'the source of contractual relationship that guarantee stable interactions and exchange', but also is partaker of policy making process and innovation promotion. After World War II, US have been dominant in the development of theories and practices about university research's social value and government policies for its support, in particular, the Bayh-Dole Act is viewed as a milestone and one of the determinants which underpins tremendous development in commercialization of university technology in the US (Mowery et al., 2004; Pavitt, 2001). Many other countries have therefore been monitoring the development of US university innovation system and endeavour to mimic some of its policies and mechanisms (Collins & Wakoh, 2000; Loftus & Sillars, 2005; Toshiya, Shigemi, Michi, & Dai, 2006). Nevertheless, other countries have developed their own government policies to accommodate their individual situation (European Commission & Federal Ministry of Economy and Labour Austria, 2001; OECD, 2001; Owen-Smith, Riccaboni, Pammolli, & Powell, 2002). This section presents a retrospective review of the UK government's involvement in promoting university knowledge transfer over past several decades.

In the UK, the institutional setups have been playing pivot role in the development of university industry interactions over the past half century. In 1949 the UK government set up the National Research and Development Corporation to promote the transfer of publicly funded research to industry. During the period from 1950 to the late 1960's, however both academics and industry did not commit to establish productive relationships, especially as industrial and academic scientists were suspicious about their respective roles (Hoorebeek, 2005; Howells et al., 1998). In this context, government kept on engaging in enhancing the university knowledge transfer. In mid 1970s, the government averted direct legislative intervention and followed a polycentric approach(Grady & Pratt, 2000) to knowledge transfer, and correspondently introduced the centralized autonomy to university for governing their intellectual property. In the year of 1975, the National Enterprise Board was formed and subsequently merged with the National Research and Development Corporation to become part of the British

Technology Group. At that time the British Technology Group had formal monopoly rights on the exploitation of research and development generated within government research establishments and on the work funded by the research councils in higher education institutions(Shohet & Prevezer, 1996). Nevertheless, the role of British Technology Group is relatively limited as it just patented university research outputs and undertook licensing them to commercial companies, although the grant of licences usually took a non-exclusive form, which neglected the value of other entrepreneurial activities in the university.

The turning point for the university knowledge transfer sector in the UK took place as the result from universities experiencing funding pressure. As Grady(2000) stated 'In the 1980s following government cuts in higher education funding institutions looked for alternative sources of funding and to change their attitudes towards industry, especially as the government had made some funding available to assist the process of knowledge transfer...In addition, new government funds were introduced for technological research supported by industry, and to assist in the exploitation of research results'. University industry knowledge transfer started to be viewed as a solution that can be used to help making up the shortfall or lessen the funding pressures on universities.

The UK government and universities have been closely monitoring the growth of the US knowledge transfer sector, especially the enactment of the Bayh-Dole Act that achieved the intended results: to encourage the disclosure and protection of innovation from publicly supported research; and to see the commercial development of products from such innovation for public benefit(Mowery et al., 2004). In a recent paper, Pavitt (2001) cautioned against adoption of the US system in other countries. Although the legislative lead of the US was not followed, throughout the 1980's various steps were taken in the UK's conservative government under Margaret Thatcher to rationalise the university knowledge transfer sector (Hoorebeek, 2005). The UK government has been actively trying to promote what it sees as leading edge practice from the US. The series of White and Green papers and the abolition of the British Technology Group's monopoly reflected many of the tenets expressed in the Bayh-Dole Act.

In 1985 a Green paper was published with the aim of improving the relevance of higher education to the needs of business and the commercial world, and a White paper followed in 1988, published by the Department for Trade and Industry (DTI) that emphasised importance of university knowledge transfer in the economic

development(Grady & Pratt, 2000). A White Paper published by government in 1993 attempted to establish 'systemic' interchange between industry, scientists, engineers and policymakers and represented the first attempt to provide a unified approach to knowledge transfer by providing an overall national policy on technology and knowledge transfer(Office of Science and Technology, 1993). This report was produced through a technology foresight programme involving industry, the research community, research charities and government departments who inform the government on research and technology programmes and the associated policies. In July 1997 the first major review in 35 years (since the Robbins Committee in the early 1960s) of the UK's higher education structure was published by the National Committee of Inquiry into Higher Education(1997) (known as the Dearing Report). The Dearing Report confirms the importance of partnerships between higher education and industry, expressing the desire to make higher education more responsive to the needs of local industry and commerce. The DTI White Paper titled as 'Our Competitive Future' in 1998 committed the government to support business in developing knowledge based competition and made specific reference to the important role of universities(Department of Trade and Industry, 1998). Moreover, for the purpose of revealing the situation of UK university industry interactions, since 2002 there has been a regular survey of interactions between business, the community and universities. The Higher Education Business and Community Interaction Survey (HEBCI) has collected data from all HEI's on the nature and extent of their relationships with business. The metrics in the HE-BCI survey to which most prominence has been given by policy makers and others are the transactions which reflect a linear mode of knowledge transfer such as patents, licences and spin out activities by universities.

The UK government is climbing a learning curve of steering and supporting the university industry interactions. In 2003 the Lambert Review(2003) made a series of recommendations aimed at smoothing out the interactions between Britain's strong science base and the business community, and also pointed out that the KTO is one of the major barriers in knowledge transfer from university to industry. In 2006, the Sainsbury Review(2007) 'The Race to the Top of the UK innovation system' made a number of recommendations including doubling the number of KTPs, and adopting a formulaic approach to HEIF funding. The Review also suggested a very simplistic segmentation of universities including research intensive and business facing: with research intensive universities pursuing 'knowledge transfer' and business facing

universities pursuing 'problem solving', which is consistent with Alan Hughes' proposition(2006) regarding the roles the university is playing in economic and social development.

Alongside various policy papers and reviews, from 1980s UK government has launched a series of initiatives to promote university knowledge transfer (European Commission & Federal Ministry of Economy and Labour Austria, 2001). Although government commits to improve the links between university and industry through these initiatives, they created an already confusing array of initiatives which are in turn, applied to a wide range of different kinds of organisations concerned with knowledge transfer in the UK(Grady & Pratt, 2000). For instance, in 1983 the University Grants Committee provided support for institutions that attracted industrial funding and beginning with the Alvey Programme and Joint Opto-electronic Research Scheme. As such the mechanism of collaborative research between universities and industry was introduced, and continues to the present day in the form of LINK programmes and through participation by UK HEIs and industry in the European Union's Framework Programmes. Additionally UK government initiated the Higher Education Innovation Fund (HEIF) to support and develop a broad range of knowledge exchange activities between universities and business. HEIF has greatly supported the universities' third stream activities, for instance its third round (HEIF 3) has provided around £200m over 2 years from 2006 and the fourth round of HEIF has raised a final year allocation of £150 million for 2010-11. In terms of cultivating the entrepreneurships in universities, the University Challenge Seed Fund launched in 1998 was aimed at projects that moved technology closer to the market and acted as a springboard for spin out companies. The Science Enterprise Challenge provided funds for projects in Entrepreneurial Education and Higher Education Reach Out to Business and the Community and its descendant. Also dating from that period are two schemes designed to support industrially relevant training: Co-operative Awards in Science and Engineering (CASE) studentships and the Teaching Company Scheme (European Commission & Federal Ministry of Economy and Labour Austria, 2001; Holi et al., 2007; Howells et al., 1998; Lambert, 2003; Molas-Gallart et al., 2002).

2.4. The emerging innovation theories

As aforementioned, university knowledge transfer is embedded in the system of innovation, and therefore it is highly impacted by the evolution of business innovation.

Over the past several decades, advanced by globalization (Stiglitz, 2006) and technology progress (Dodgson et al., 2005), innovation has experienced a dramatic shift from the technology focused to the business model focused (Chesbrough, 2003a), and from a linear push model to the networking and integration model (Rothwell, 1994b). This section intends to review two emerging innovation theories which influence the development of university knowledge transfer, namely, open innovation and the fifth generation of innovation shown as follows.

2.4.1. Open innovation

The term 'open' in innovation has been explained in many different ways (Gassmann, 2006), such as 'open market innovation'(Rigby & Zook, 2002), 'outsourcing of R&D(Quinn, 2000)', 'open source'(West & Gallagher, 2006a) and 'external commercialization of technology' etc (Grupp, 1996). Chesbrough (Chesbrough, 2003b) defines it broadly as 'a paradigm that assumes that firms can and should use external ideas and internal and external paths to market, as the firms look to advance their technology', or more explicitly as 'open innovation is the use of purposive inflows and outflows of knowledge to accelerate international innovation, and expand the markets for external use of innovation respectively'. Many different types of initiatives fall under the rubric of open innovation: scanning the external environment for ideas, reaching out to a specialist on a contract basis to solve a particularly difficult research problem, forming a joint venture, and even licensing technology from a university or participating in broad networks to coordinate innovation activity (Hagel & Brown, 2006), which bring the role of universities in that context into the light. Advocating universities as one of the major sources of industrial innovation, Chesbrough has recommended that building close relationship with university is critical for business to adopt open innovation (Andrews, 2003).

The emergence of open innovation roots in the development of a variety of social and economic factors. Chesbrough (2003b, c) proposed five conditions that drive the innovation process from closed to open, i.e. the mobility of personnel, the rising quality and relevance of university research, the explosion of human capital, the growth of international research, and the growth of venture capital and private equity. Dahlander & Wallin (2006) argued that the drivers of open innovation include globalization, improved market institutions, technological change, increased labour market mobility. In summary, the drivers for business to adopt open innovation could be considered in

two complementary clusters: internal pressure and external impetus. The internal pressure comes from the rising of the innovation cost, the increased complexity of innovation process, and shorter product lifecycle. The external impetus can be summarized as three factors: 1) institutional factors, e.g. the improved market institution, risk of market and globalization; 2) technological factors, such as the increasing research quality, risk of technology and the boom of information technology (Dodgson, Gann, & Salter, 2006); and 3) individual factors including the explosion of human capital and the high mobility of personnel. The university therefore can play significant roles to bolster the development of open innovation.

Open innovation also highlights the importance of absorptive capabilities of companies. From a resource based view, the capabilities (Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997) of companies are regarded as a key resource to sustain the competitive advantages. With respect to the innovation performance, the capability to exploit external knowledge is also of great significance (Cohen & Levinthal, 1990), in particular pertaining to the process of university knowledge transfer (Fabrizo, 2006). Through addressing the capability issue Chesbrough and Schwartz (2007) redefined the R&D capability to embrace co-development partnerships for the purpose of innovating the business model, and emphasise that companies need to develop the abilities to experiment with their business models for the purpose of partaking more fully in the benefit of open innovation. In addition, Cooke (2005a, b) puts forward the importance of regional knowledge capabilities in the implementation of open innovation in certain knowledge region, in which the creation of entrepreneurial university is regarded as the key(Etzkowitz & Klofsten, 2003).

Challenges for business adopting open innovation have also been studied. Fettergoff and Voelkel (2006) proposed a 'SERVE' model representing Seeking opportunities, Evaluating the market potential, Recruiting potential partners, Value capturing and Extending the innovation offering. West and Gallagher (2006a; 2006b) argue there are three major challenges for open innovation, that is, maximizing returns to internal innovation, incorporating external innovations, and motivating spillover. Bautista (2005) suggests the challenges of open innovation in five areas: 1) difficult and complex relationships, 2) selection of right partner, 3) shape of the commercial deal, 4) the right knowledge management practice to nurture and sustain relationship, 5) IP issues.

Hagel and Brown (2006) pointed to two major obstacles that prevent organizations

from achieving greater success with open innovation. First, there is a lot of confusion over what open innovation actually involves. Second, there is even more confusion over the management techniques required to deliver continuous value from open innovation initiatives. In response to these obstacles, solutions such as 'Creation Nets' - an inter-organizational knowledge network model (Vanhaverbeke, 2006), and innovative business models (Chesbrough, 2003b) have been offered as cognitive ways to clarify the confusions. business model is the core of the open innovation paradigm, which defines the activities in the innovation process, and identify the resource and capabilities required (Chesbrough, 2007). In this sense, theoretically business model serves as a bridge connecting technological input and economic output.

2.4.2. Fifth generation of innovation

As mentioned before (seen in **Section 2.1**), over past several decades, it has been acknowledged that innovation processes have evolved from simple linear models to more complex, systemic and iterative approaches. During the 1950s and 1960s, the research-push or first generation model was prevailing (Rothwell, 1994a). This approach assumes that innovation is a linear process, beginning with scientific discovery, passing through invention, engineering, and manufacturing activities, and ending with the marketing of a new product or process. The management challenge at that time was simply to increase effectively investments in R&D (Gann & Dodgson, 2007). From the early- to mid-1960s a second linear model of innovation was adopted by public policy-makers and industrial managers: the demand-pull or second generation approach. In this model, innovations derive from a perceived demand, which influences the direction and rate of technology development. The management challenge was simply to invest effectively in marketing and plan efficiently around identified customer demand. Both linear models of innovation were oversimplified representations of what actually happens in innovation processes(Narin et al., 1997). For instance, Rothwell(1994a) pointed out that at an industry-wide level the importance of research-push and demand-pull may vary during different phases in the innovation process, and across industry and market sectors. In this stage, the university's involvement in the innovation process is limited and rigid. By the 1970s, the coupling or third generation model became evident. This involved integrating both research-push and demand-pull approaches and was centred on an interactive process with its emphasis on the feedback effects between the market and research phases of the earlier linear models. The

management challenge of this process involves significant investments in cross-organisational communications and integration(Gann & Dodgson, 2007).

The fifth generation innovation process, which appeared in the 1990s, more fully encompasses the high levels of strategic and technological integration found between different functions and organisations inside and outside the firm(Rothwell, 1994a). The fifth generation moves away from the 'silos' of functional divisions – such as R&D, marketing and operations – towards organisation according with business processes. The value-creating activities of business are intimately linked with its suppliers and customers and the networks and communities to which the company belongs. Lead-users and first tier suppliers are brought into the centre of the process(Hippel, 1988). In short the fifth generation innovation is featured as integration, flexibility, networking and parallel information process(Rothwell, 1994a). Albeit the fifth generation of innovation perspective focuses on the business innovation, it mirrors the university's role change along with the evolution of business innovation. As the challenges of business innovation shift from investment in R&D to integration with internal and external partners, university, which was seen just as functions of education and research became the proactive partaker of innovation(Etzkowitz, 2003a; Etzkowitz et al., 2000).

3. Main issues of university industry links

There is a plethora of literature regarding the entrepreneurial university, the university knowledge transfer, as well as knowledge transfer offices (Phan & Siegel, 2006; Rothaermel et al., 2007; Siegel et al., 2007). Generally, three major research streams can be identified to delineate and analyze university industry links. The first one is the 'process focused' stream, which argues that university technology commercialization should be treated as a 'process' of knowledge transfer (Debackere & Veugelers, 2005; Murray, 2004; Siegel et al., 2003a). To enhance academic research commercialization, universities have to deal with gaps, barriers and incongruence among stakeholders involved in the transfer process. The second stream is the 'institutional and organizational elements' stream. This stream argues that favourable institutional and organizational resources including supportive commercial infrastructure, organizational incentives, strength of research base, and availability of venture capital play significant roles in enhancing academic research commercial performance (Bercovitz et al., 2001; Chapple et al., 2005; Jones-Evans et al., 1999; Macho-Stadler, Perez-Castrillo, &

Veugelers, 2007). Thirdly the stream of 'performance measurement' endeavours to enhance the effectiveness and efficiency of university knowledge transfer, which is of concern by policy makers and knowledge transfer practitioners (Chapple et al., 2005; Phan & Siegel, 2006; Siegel et al., 2004; Siegel et al., 2003b). Importantly all of these streams of research overlap and intermingle, reflecting the general acceptance of the main thesis of the entrepreneurial university which generally reflects key issues pertaining to the contemporary university innovation system.

3.1. The entrepreneurial university

The term 'entrepreneurial university' was coined by Etzkowitz (1998)to describe the instance in which universities have expanded their conventional functions to embrace a wider spectrum of activities outside the ivory tower with the goal of transforming inventions into innovations for the advances of society and to enhance the university's income and capital endowments(Etzkowitz, 2003a). According to Rothaermel et al(2007), the entrepreneurial university is the centre of the university innovation system, which 'generates technology advances and facilitates the technology diffusion process through intermediaries such as knowledge transfer offices and the creation of incubators or science parks that spawn new firms'.

The entrepreneurial university is viewed as a step in the evolution of a university system that emphasizes economic development in addition to the more traditional mandates of education and research(Etzkowitz, 2003a, b). University used to develop its own value system and academics had their own norm of behaviour consistent with the disposition of members in the academic community (Delanty, 2002; Louis & Anderson, 1998). During that time, bringing innovations to market had not been the main role of university-based researchers. Over the last two decades, there has been a considerable shift in the perception of the university's role, primarily due to the changing importance and nature of knowledge in the emerging knowledge based economy but also attributable to government policies that aim at enhancing international competitiveness in global markets through industrial innovation that has created an expanding demand for which universities are expected to supply (Cohen et al., 2002; Fabrizo, 2006; Jaffe, 1989; Mansfield, 1991; Thursby & Thursby, 2006). By this token, the conventional concepts of academic research, dissemination, and even education are all being redefined, resulting in changes, sometimes dramatic but often more incremental, in the

organization per se and the behaviour of academics(Clark & Society for Research into Higher Education, 2004; Clark, 1998; Marginson & Considine, 2000).

With entrepreneurialization universities no longer merely serve as the source of technological advances for industry, but also proactively engage in the dissemination, diffusion deployment of knowledge through adopting a variety of business models (Etzkowitz, 2003c; Etzkowitz et al., 2000). In short, in the 'entrepreneurial' era, universities have worked up the boundary spanning structures and mechanisms to interact with the "outside" world of businesses, communities and government agencies(Clark, 1998; D'Este & Patel, 2007; Etzkowitz, 2003a), have diversified funding base beyond sole reliance on government(HEFCE et al., 2007; Hughes, 2006) and more importantly, have an integrated entrepreneurial culture to accommodate commercialisation activity and university-business interaction(Clark, 1998). In this vein, the research on the entrepreneurial university are centred on the changes of organizational and operational elements pertaining to the university innovation systems, such as the structure(Bercovitz et al., 2001), incentive system(Markman, Gianiodis, Phan, & Balkin, 2004), location(Cooke, 2005b; Etzkowitz & Klofsten, 2003; Friedman & Silberman, 2003), faculty development(Thursby & Thursby, 2005), academic entrepreneurship (O'Shea et al., 2004; Wright et al., 2007) and culture (Jacob, Lundqvist, & Hellsmark, 2003; Lee & Gaertner, 1994) etc. Moreover, the university's interactions with environment in the era of entrepreneurialization are also under thorough study in this area, which includes the influence of government policy (Jelinek & Markham, 2007; Mowery, Nelson, Sampat, & Ziedonis, 2003; Sampat, 2006) and business innovation (Fabrizo, 2006).

In addition, researchers also recognize that the shift of the university system from a research and education focused ivory tower style into a collective entrepreneurial institution and active partaker of innovation could be thorny and of high cost (Etzkowitz, 2003a; Etzkowitz & Klofsten, 2003). This shift calls for mechanisms from inside the system to accelerate technology diffusion (Rothaermel et al., 2007). Consequently many researchers have been attempting to resolve the conflicts that arise as universities become more entrepreneurial (Debackere & Veugelers, 2005; Thursby et al., 2001), taking into account the issues pertaining to the evolution of the traditional university mission and offering suggestions on how to address these issues(Etzkowitz, 2003a; Etzkowitz et al., 2000; Lee & Gaertner, 1994; Powell & Owen-Smith, 1998).

3.2. Understanding the knowledge transfer

3.2.1. Knowledge diffusion

University knowledge transfer is essentially the diffusion of knowledge from university to business and wider community. According to Everett Rogers(1995), the diffusion of knowledge is the process by which the innovation is communicated through certain channels over time among members of a social system. He also points out that there are four key elements in the innovation diffusion process, namely, the innovation, the communication channels, time and the social system(Rogers, 1995). Another author, Lawrence(1981) defined the knowledge diffusion in the light of the change of distributional characteristics associated with innovations. He argues that as the characteristics are changing over time, the process by which such change occurs, that is, by which innovation spread from one locale or one special group to another is called innovation diffusion.

According to Rogers(1995), there are two types of knowledge diffusion: centralized or decentralized. In terms of the centralized diffusion, innovation are created by technical subject matter experts in R&D centres and diffused through central administrators, who decide which innovation to diffuse and to whom. In contrast, with respect to the decentralized diffusion, the innovation are created by non-experts who are often users themselves, which is similar to Von Hippel's (2005) user leading innovation. Unlike the top-down decision making in centralized diffusion, decentralized diffusions happen through peer-to-peer networks where the adoption decision is made by the receivers based on their own evaluations, i.e. in a bottom-up manner. In the case of university knowledge transfer, the decentralized trend refers to the situation that the knowledge transfer activities are conducted in departments(Debackere & Veugelers, 2005; Thursby & Thursby, 2005) , research centres, or even at personal level(Blumenthal, Campbell, & Causino, 1996).

This trend partly is caused by two factors: the first is the technological specialisation which means the departments of university are more likely to understand the value and utilization of special technology and therefore have more capability to undertake the knowledge transfer mission; and the second factor is the existence of different clock-speed between university and industry. In the business world, companies encounter faster market changing than the university does, as the result the industrial

business require quick decision making process and flexible communication channels. In this sense, in terms of the efficiency of decision making the centralized university knowledge transfer may have less advantage than the department or research centre based knowledge transfer(Debackere & Veugelers, 2005). Additionally the most salient feature of innovation diffusion theory is that, for most members of a social system, the innovation-decision depends heavily on the innovation decisions of the other members of the system(Rogers, 1995), and this mirrors the multiplicity and complexity of university knowledge transfer which will be explained in the later section of this chapter.

3.2.2. Definition of university knowledge transfer

Similar to the notion of 'knowledge diffusion', the term 'knowledge transfer' has been widely used by different organizations in a variety of ways. Roessner(1988) argued that the term of knowledge transfer has been used to describe and analyze 'an astonishingly wide range of organizational and institutional interactions' involving some form of technology-related exchange. Moreover, Zhao and Reisman(1992) summarised the definition of knowledge transfer into four streams, namely, economics, sociology, anthropology, as well as management and stressed 'the very definition of knowledge transfer differs among the various approaches and certainly across the many disciplines addressing this subject'. They differentiate knowledge transfer definitions via identifying the perceptions of 'technology' by different groups of views. This way of thinking also can be found in some other researchers, say for example Eveland (1986) and Rogers (2002). From viewpoints of Zhao and Reisman (1992), economists tend to define technology on the basis of the properties of generic knowledge, focusing particularly on variables that relate to production and design. Sociologists however tend to link knowledge transfer to innovation. For instance, Rogers (2002) defined that the knowledge transfer is essentially a communication process through which the results of scientific research are put into use. Anthropologists tend to view knowledge transfer broadly within the context of cultural change and the ways in which technology affects change. Moreover, those from the management disciplines endeavour to focus on stages of knowledge transfer, particularly relating design and production stages, as well as sales, to transfer. In short, a comprehensive definition was provided by Brooks (1966) who generalized the concept of knowledge transfer as 'the process by which science and technology are diffused throughout human activity'...wherever systematic rational knowledge developed by one group or institution is embodied in a way of doing things

by other institutions or groups, we have knowledge transfer'. This can be either transfer from more basic scientific knowledge into technology or adaptation of an existing technology to a new use. In addition, he also emphasized 'the knowledge transfer differs from ordinary scientific information transfer in the fact that to be really transferred, it must be embodied in an actual operation of some kind'(Brooks, 1966).

Those definitions mentioned above have offered the general understanding of knowledge transfer in a broad perspective. Nevertheless for the purpose of this thesis, the understanding of knowledge transfer should centre on the university perspective, that is to say, the 'source' of technology is university, the 'object' of transfer should be university knowledge, and the 'channels' of transfer are also university's relevant sections. According to Bremer (1998), the notion of university knowledge transfer – the transfer of the results of research from universities to the commercial sector – has had its origins in a report made to the President Truman in 1945 by Vannevar Bush (1945) which has been mentioned in **section 2.1.** Bremer also stressed that long before the Vannevar Bush's concept, the universities have been engaged in the transfer of the technology, although that specific term may not have been applied to their activities(Mowery & Rosenberg, 1998). Similarly Loftus and Sillars(2005) defined the university knowledge transfer as the process whereby new ideas embodied in academic inventions and discoveries are transformed or 'translated' as they move from laboratory bench to the commercial mainstream. Moreover, AUTM(2003) suggested that the university knowledge transfer can be more narrowly defined as 'the process whereby inventions or intellectual property from academic research is licensed or conveyed through use rights to industry'. Some researchers suggested further definitions to assist the understanding of university knowledge transfer. For example, Dill (1995) considered the 'capitalization' of knowledge and suggested that the university knowledge transfer 'involves formal efforts to capitalize university research by brining university research outcomes to fruition of commercial ventures'. In addition, the management style definition is also given, for instance, Lita Nelson et al (Nelsen, 2001) gave a more practical definition as 'purposeful transfer of the results of fundamental research from universities and research institutions into the economy via protection and out-licensing of intellectual property'. Generally, the definition of university knowledge transfer has two main elements: the transfer objects which include the tacit and explicit university intellectual property and personnel etc, and the transfer channels including licensing, joint research, spinout, consultancy and so forth.

3.3. Processes and channels

In the era of entrepreneurial university, the channels, through which university transfer its intellectual property to business and even wider community, have been broadened to include a wider spectrum of models to accommodate various demands by stakeholders and nature of to be transferred intellectual properties(D'Este & Patel, 2007; Shane, 2004; Thursby & Thursby, 2007). In different channels, the processes of knowledge transfer behave distinctly(Loftus & Sillars, 2005), nevertheless almost all channels exhibit in a stage-gate manner, in particular, from the value chain perspective the value of knowledge transfer is added in different stages. As such, considering the considerable literature has accumulated on the subject of knowledge transfer processes, this section splits the literature regarding the knowledge transfer process into two streams: the spectrum of channels which focuses on analysis of each channel of knowledge transfer, as well as the stage-gate form of processes, which is centred on the consideration of the common stages of knowledge transfer processes.

3.3.1. A spectrum of channels

There is burgeoning empirical literature showing an increasing level of university knowledge transfer activities, such as patenting and licensing, as well as generation of spin-out companies(Friedman & Silberman, 2003; Shane, 2004; Thursby & Thursby, 2007), which have been accompanied by an increase in consultancy, collaborative research and joint scientific publications (D'Este & Patel, 2007). This section reviews the relevant literature regarding the university knowledge transfer channels, including two main mechanisms through which the knowledge and expertise possessed and developed by universities can flow directly to industry: the licensing of university intellectual property and spin-out (European Commission & Federal Ministry of Economy and Labour Austria, 2001), as well as another widely practiced activity of academic consultancy (HEFCE et al., 2007).

3.3.1.1. Knowledge transfer via licensing

Licensing outcome of university research to established firms seeking to incorporate the technology into products they sell is the most common practice by universities. Licences can be either exclusive -- granting the sole right to a single company in a single country, region or market sector, or non-exclusive. Since 1980s licensing of university inventions

to industry has been one of the most rapidly changing areas in the licensing of new inventions. In the US, the enactment of Bayh-Dole Act has considerably increased the university's patenting and licensing activities (Mowery et al., 2004; Mowery et al., 2003). Hellmann (2007) argues that in such a setting intellectual property rights owned either by the inventor or the university may be important in promoting commercialization. Inventors often have tacit knowledge necessary for commercial development, and the incentive provided by revenue sharing can clearly play a role in commercial development (Jensen & Thursby, 2001). In the UK, according to the 1977 Patents Act, IP created by university employees shall be owned by the university if the IP was created in the course of the employee's normal or specifically assigned duties. Also the university's licensing activities increased greatly which partly is attributed to the government's initiatives to improve the university knowledge transfer since 1980s. An example is that the privatization of British Technology Group authorised universities with the right to commercialize their technology. It is worth noting that despite significant developments in the licensing activity over the past three decades the empirical evidence shows that the payoffs are greatly varying between inventions that it can hardly be imagined that licensing income is a stable source of finance for universities. In the US context, half of all universities have less than 1 million USD$ licensing income per year (which is a relatively small amount, even when compared to the budget of an average European university). Moreover, only a few patents are responsible for the majority share of licensing income (Powell, Owen-Smith, & Colyvas, 2007).

In extant literature, some factors appeared to have impacted the university's engagement in licensing activities. Mitchell(1991) investigated the licensing activities in the medical diagnostic equipment discipline and found that the increases in university licensing and patenting is significantly related to whether the universities have established specific knowledge transfer offices to handle the university patenting and licensing activities. Friedman and Silberman (2003) studied university knowledge transfer offices and found that there was a positive relationship between the size of knowledge transfer office (number of professional staff) and the number of licenses held by the university. In addition, they(2003) also revealed that the number of invention disclosures influences licensing agreements, while faculty quality affects the number of disclosures. In the same vein Siegel et al (2003a) emphasized the significance of boundary spanning skills by staff of knowledge transfer offices.

Research on licensing since late 1980s offers further insight into this channel of knowledge transfer. For instance through study of UK universities Lowe (1993) revealed that disciplines such as material, electronics and pharmacology which have longer R&D time were the fields which are most likely to reach licensing agreements as opposed to choosing other knowledge transfer channels such as creating spinouts. Moreover, through the case studies in US universities Matkin (1990) pointed out universities with successful licensing programmes have a strong culture of entrepreneurship among their academic staff, and universities that have more autonomous or knowledge transfer units were more successful in building links with businesses.

Recently, researches offered further insights regarding the university licensing activities, such as Thursby and Thursby (2002) found that increased licensing is due primarily to an increased willingness of faculty and administrators to license and increased business reliance on external R&D rather than a shift in faculty research. Jensen and Thursby (2001) conducted a quantitative research from the faculty perspective and revealed that faculty proclivity to license is influenced by their ability to share the royalty income from a license and the university's willingness to allow then an stake in a company holding a university license. Moreover, Thursby and Thursby (2003)studied the licensing from the business perspective, and revealed that many firms choose not to license from universities because of the embryonic nature of university technologies, hence the risk sharing would be the main factor that influences the business' intention to select the licensing from university.

3.3.1.2. Knowledge transfer via new company creation (e.g. spinout)

A spinout can be defined as a start-up company whose formation is dependent on the intellectual property rights of the university, and in which the university holds an equity stake. Often, but not always, these firms are founded by the academic researcher responsible for the invention(Loftus & Sillars, 2005). They are viewed as the more entrepreneurial alternative to licensing by many researchers and knowledge transfer officers(Shane, 2004; Wright et al., 2004a). This viewpoint roots in the analysis of the value adding aspect of university knowledge transfer process. That is to say, essentially the value of patented technology would increase when it evolves towards a viable commercialized product. Accordingly the more the university or faculties can involve in

the knowledge transfer value creation process, meanwhile the greater potential payoff the university could gain, which however involves a higher risk in its place.

University knowledge transfer via creation of spinout companies has gained significant development over the past decades(Library House, 2006; Lockett, Wright, & Franklin, 2003). Accordingly literature regarding this aspect of university knowledge transfer has expanded and developed to a great extent. Researchers in this stream have found that factors such as university policy, faculty, knowledge transfer offices, investors, founding teams, networks in which a firm is embedded, and external conditions can effectively impact the university spinout activities (Rothaermel et al., 2007). Based on a survey of knowledge transfer and business development officers at 57 UK universities, Locket et al (2003) found that the more successful universities have clearer strategies towards spinning out companies and the use of surrogate entrepreneurs in this process. In addition, more successful universities were found to possess a greater expertise and networks that may be important in fostering spin-out companies. Shane and Stuart(2002) argued that founder's direct and indirect relationships with venture investors help new ventures to receive venture capital funding and to avoid failure. Founder team's industrial experience and patent effectiveness have positive effect on IPO, venture capital funding rate, and negative effect on the failure. O'shea et al(2004) reviewed the literature of academic entrepreneurship and suggested that Individual and the personality of the individual as the key determinant of whether spin-off activity occurs, and summarized the organizational configuration explaining spin-off activity in terms of resources of the university. In addition, they also proposed the performance measurement of spin-out activities. In another study O'shea et al(2005) also argued that previous success in knowledge transfer, faculty quality, science and engineering funding base with an orientation in life science, chemistry, and computer science disciplines, percentage amount of industry funding, and a strong commercial resource base are all positively related to university spin-out activity. Among these researches, success factors behind the process of university spinout activities are also identified and studied. For instance the university policies on intellectual property strategy are associated with a higher number of university spin-out (Gregorio & Shane, 2002), networking activities of founders or founding teams strongly influence the performance of spinout firms (Shane & Stuart, 2002), and overall university involvement and strategy (Clarysse, Wright, Lockett, Mustar, & Knockaert, 2007; Lockett et al., 2003). In addition the process of creating spinout company is also under analysis(Ndonzuau, Pirnay, & Surlemont, 2002).

KTOs are also one of the critical elements influencing the universities' spinout activities. Leitch and Harrison (2005) studied the supportive role KTOs can play in university industry interactions. However the Lambert Review (2003) argued that KTOs had engaged in too little licensing of university IP and were creating too many unsustainable spin-outs, going so far as to recommend a rebalancing of activities away from creating spin-outs and towards licensing of technologies. In addition, recruiting experienced individuals into KTOs who brought specialist commercial skills or an industrial background was found to be difficult (Wright et al., 2007). Additionally, the Bank of England(Quarmby, 2002) found that constraints on the resources of KTOs and the complexity of processes within universities when conducting commercial negotiations were barriers to creating quality spin-outs and accessing equity funding. Markman et al (2005) found that the faster KTOs can commercialize patent-protected technologies, the greater their licensing royalties and the more new ventures they spin off.

3.3.1.3. Knowledge transfer via consultancy

University knowledge transfer via consulting is highly ranked and widely practiced among businesses as a vehicle through which industry accesses public research(Cohen et al., 2002; Mansfield, 1995). This mirrors the 'problem solving' function that Alan Hughes proposed for depicting university roles in the entrepreneurial university era(Hughes, 2006). Academic consulting can be defined as the provision of a service by academics to external organisations on commercial terms based on their expertise in specialist fields(Perkman & Walsh, 2008). This may involve giving advice or resolving problems within design, production or other corporate functions, sometimes by utilising specialist equipment in university laboratories, where the tacit knowledge is mainly transferred.

Albeit being practiced widely, for instance empirical research suggest 10-25 % of academics carry out external consulting in any one year (HEFCE et al., 2007), the remit of consulting is limited as Goldfarb and Henrekson(2003) stated that academics are much less likely to face strong incentives to continue to devote time and resources to successful commercialization when consulting is the only tool. Nevertheless, consulting has been found to be a significant predictor of all other forms of academic entrepreneurship (Louis, Blumenthal, Gluck, & Soto, 1989). Some research also suggested that the combination of consulting with other mechanisms can increase the level of knowledge transfer. For instance Ormerod (1996) argues that there can be

strong synergy between research, teaching and consultancy; integrating these activities can create a virtuous circle of social engagement, new research ideas, and opportunities for developing new teaching programmes. Moreover, albeit much emphasis in the literature is on the transfer of technology as an output of academic research, consulting may involve the mobilization of more common expertise and more tacit knowledge required especially at the latter stages of the innovation cycle(Feller, 1999). In order to assist the comprehension of university consulting activities, Perkman and Walsh(2008) proposed three types of academic consulting, namely, opportunity-driven consulting, commercialization-driven consulting and the research-driven consulting.

3.3.2. The stages of the process: a value chain perspective

Albeit university knowledge transfer involves a wide range of channels, the general process exhibits a similar stage-gate manner(Ndonzuau et al., 2002; Siegel et al., 2003a). In the course of knowledge transfer, value is added along with the process. Hence it is worthwhile to analyze the general knowledge transfer process for the purpose of improving the process. In this regard, this section intends to analyze the university knowledge transfer from the value adding perspective, where the knowledge value chain model is considered.

The knowledge value chain perspective – which has been widely adopted in the knowledge management domain (Holsapple & Jones, 2005; Holsapple & Jones, 2004; Shin, Holden, & Schmidt, 2001) – offers a rigorous and dynamic framework for understanding the process of knowledge management and its key managerial elements. The knowledge value chain not only serves as a framework to facilitate the comprehension of the knowledge diffusion process, but it also can translate the organization's knowledge management strategy into the tactical operations management issues, examples of which includes coordination of interactional knowledge management activities, knowledge project management, and infrastructure management etc. Most of the knowledge value chain models are based on the analysis of the innovation diffusion from the industrial business perspective, nevertheless, the knowledge value chain is more than the 'stage' and 'action' of the knowledge diffusion system. Generally there are two major types of the knowledge value chain models exist in literature, namely the 'operations focused' knowledge value chain and the 'knowledge production focused' knowledge value chain, illustrated in **Table 1**.

Table 1 Literature regarding the knowledge value chain

Author	Constructs of value chain	Rationale	Type
Lee & Yang (2000)	knowledge management infrastructure, knowledge management process activities, knowledge performance metrics	M. Porter's Value chain	O
Holsapple & Jones(2005; 2004)	Primary knowledge management activities, Secondary knowledge management activities	M. Porter's Value chain	O
Wong(2004)	Seven knowledge management states and six actions	C. Lee's KVC & Nonaka's KM	O
Carlucci (2004)	Four assumptions based on performance measurement	BSC, EFQM, & Performance prism	K
Eustace(2003)	Capability, competency, intangible, tangible	EU PRISM	K
Yoon(2002)	Four knowledge reconstruction levels	Definition of knowledge level	K
Lev(2001)	nine blocks of value chain scoreboard	The value of intangible capital	O
Roper(2005)	Knowledge sourcing, transformation and exploitation	Taxonomy of knowledge activities	O
Chen(2004)	Knowledge Input, output and activities	BSC, Drucker & Nonaka	K
Major & Cordey-hayes (2000)	Five stages of knowledge translation	Characteristic of knowledge	K
Shin(2001)	Four stage of knowledge management, Five streams of knowledge management focuses	A range of definitions of knowledge management	K
Alavi & Leidner (2001)	Four activities of knowledge management Loops from final activities to first one	Knowledge management activities	O
Davenport (1998)	Creation, transference and assets management	Project management	K
Hansen & Birkinshaw (2007)	Idea generation conversion, and diffusion	Innovation strategy	O
Powell(2001)	Two knowledge activities sets, two types of knowledge management participants, states and actions	C. Lee's KVC, & value of knowledge	O

'O' denotes the operation focused and 'K' denotes the knowledge production focused

The operations focused knowledge value chain places the emphasis on the identification of knowledge management activities, and it tries to reveal the links between the interactional activities and coordinate them in the value process. The analysis on the knowledge management activities and their relationship is seen as the central means to reveal the value adding in the knowledge management. This kind of knowledge value chain models is often illustrated as the classical value chain model by Michael Porter where the primary knowledge management activities, secondary knowledge management activities as well as the performance metrics are well defined. As the result of the recognition of the importance of the human resource in the knowledge management, some of the knowledge value chain model considered the knowledge worker and knowledge decision maker' role in the knowledge value chain management. Additionally, the value chain models of this type also take into account the interaction between the knowledge management competencies and the knowledge management activities.

The knowledge production focused value chain regards the knowledge as a special product that flow through the value chain. Most of this type of knowledge value chain is configured by stage and action. The action refers to the activities of the knowledge management, and the stage means the formality of knowledge pertaining to each action of the knowledge activity, which implies that the knowledge is transformed through the value chain. This type of knowledge value chain places focus on the transformation of knowledge, by which it is easy to ascertain the value added in the value chain. In short, both types of knowledge value chain models are focused on value adding by the knowledge management. The difference is that they place emphasis on different ways, namely, the knowledge management activities and the knowledge transformation by these activities.

A university knowledge transfer value chain model that represents the fast changing environmental issues and emerging concepts and theories should bear a number of factors including a comprehensive view of issues related to the knowledge transformation and operations of knowledge transfer, new perspectives on the maximization of joint value from knowledge transfer, openness in knowledge transfer, and handling the dynamics of knowledge transfer. These determinants require the university knowledge transfer value chain to be able to: (1) combine the merits of operations focussed and knowledge transformation focussed knowledge value chain,

which means the proposed model should reveal how the value is added and what is added to the knowledge transferred; (2) depict the openness and network characteristics of university knowledge transfer, and reveal how the joint value is created; (3) assist to diagnose the management of knowledge transfer and to identify the weaknesses of the management. A hybrid value chain model is proposed in considering these thoughts, which views the university knowledge transfer as a cyclical process including three phases, namely, knowledge acquisition, knowledge processing, and knowledge dissemination.

3.3.2.1. Knowledge acquisition

In business innovation, the knowledge acquisition offers input for the subsequent innovation activities and hence it is usually a subset of knowledge creation. Gaines (2003) suggested nine sets of activities of acquiring external tangible and intangible knowledge for the organizational innovation use. As opposed to the business innovation, generation of knowledge is not the mission of university knowledge transfer, as the university knowledge transfer is in fact the process of identification, processing and delivery of knowledge from university to business(Harman et al., 1997). Therefore, the focus of this phase is university collecting useful information for the transfer of knowledge, which covers the internal and external information sourcing. Importantly, herein the key is more than just acquiring the relevant information, but should have this information to quickly reach the potential users. Therefore, to address the problems caused by asymmetric information is one of the major missions by university knowledge transfer practitioners (Gallini & Wright, 1990). The knowledge acquisition can take place through many different channels such as meeting and workshop, publication and personal mobility etc. In this phase, knowledge exhibits in various forms of information from multiple sources, e.g. information from the potential business customers, disclosures information from academics and information about the interests from government funding bodies, etc. From this perspective, the added value exists by pooling and exchanging information in university KTOs, which implies that the stakeholders' engagement in providing useful information is critical in this phase. Nevertheless, the stakeholders' engagements (Friedman & Miles, 2006) are different according to the channel of knowledge transfer. For example in the licensing operations, in this phase, the university is more positive in collecting the information about the business innovation requirement and academic disclosure, while the business shows less

engagement in the operations. In contrast with regard to the contract research, the degree of business' engagement is much higher than in licensing. In addition, in this phase, the importance of internal and external source of information must be treated equally as all the potential collaboration afterwards must be based on the match of information from demand side and supply side (Gander, 1987).

3.3.2.2. Knowledge processing

In this stage, the major activity of university is to assess the commercial value of academic research. In the process some knowledge on market potential will be codified and tailored for business' requirement, i.e. in term of human resource mobility, training would be the major work for the university. As for contract research in this phase, university engages in the contract defined research work and tries to generate the solution for business use. In this phase, the value added in the value chain is exhibited by the usefulness of the knowledge to business, that is to say, the knowledge outcome from this phase can be readily used by the business, for example, the composed licensing package, the solution from the contract research, and consultancy and so on. The openness is still a key feature of this stage, as the university should build proper channels for getting external support in the knowledge process. An example of this is university outsourcing the training of human resources to external training companies. Similar to the first phase, the management of stakeholder engagement is still an important issue in this phase. Generally speaking, the level of business's engagement in this phase is higher than the last phase as knowledge is closer to business; therefore the management of the stakeholder engagement is from the information exchange to the operations coordination.

3.3.2.3. Knowledge dissemination

Knowledge dissemination includes university's delivering of the knowledge package to business and assistance in technology deployment. In this phase, university needs to promote the knowledge package generated from the previous stage, negotiate with knowledge users and funding bodies, and in some events academics need to work with business to deploy the technology in business. The adding value comes through two ways including the value from the information and experience gained from the work with the business, which can be used in the further knowledge transfer, and the value form university knowledge being transferred into business innovation. In this phase, the

university and business' joint engagement in the knowledge transfer is at the highest level in the all three phases because the knowledge needs to be adopted in the business. To maximize the joint value from the university business collaboration in this phase the role of network is still critical in offering information sharing and joint problem solving.

3.4. Institutions and organizations

The research of institution takes the crucial position in the literature of university knowledge transfer. Researchers argued that effective institutional and organizational platform including supportive commercial infrastructure, strong research base, and capable knowledge transfer offices play significant roles in enhancing academic research commercial performance. For the purpose of this research, this section places the emphasis on the KTOs, involving the rationales, emergence, and development shown as follows.

3.4.1. Rationales of KTOs: intermediaries

The research on knowledge transfer intermediaries has attracted considerable attention from practitioners and researchers. Intermediaries are often regarded as the function to manipulate information to reduce uncertainty and address information asymmetries. Hoppe and Ozdenoren(2002) presented a theoretical model to explore the conditions under which innovation intermediaries emerge to reduce the uncertainty problem, and argued that the role of the knowledge diffusion intermediaries is critical to smooth and accelerate the diffusion process. Biglaiser (1993), Howells (2006) and Lizzeri (1999) have investigated the role of intermediaries in addressing the information asymmetric between buyer and seller. Moreover intermediaries also play an important role in managing relations between knowledge transfer stakeholders. Shohet & Prevezer (1996) explored the role of intermediaries in relation to knowledge transfer, amongst other institutional groups, within biotechnology sector in the UK. They emphasized the important role that intermediaries play in helping to formalize informal collaborations in terms of contractual and licensing arrangements. Lynn, Reddy & Aram (1996) in their study of 'innovation communities' also identify a group of organizations that help to link and transform relations within an innovation network or system. By examining the innovation intermediaries in the UK, Howells (2006) revealed that innovation intermediaries are not only providing immediate, 'one-off' intermediary services to their clients, but are also seeking to offer longer term 'relational' innovation capabilities to them as well. Along with the rising concern over the university-industry knowledge flow

within government and universities, the formation, operations, performance and evolution of these intermediaries have become a subject of academic and practitioner research studies, as well as government watch and scrutiny in the light of financial inflow of public fund directed to support and enhance the process of innovation from knowledge through universities.

With regard to the university knowledge transfer and from an institutional perspective, establishing a specialised KTOs within the university which serves as the primary intermediary(Hoppe & Ozdenoren, 2002; Howells, 2006), or plays the boundary role (Tushman, 1977) in university industry knowledge transfer, has been viewed as an instrumental means for developing relations with industry (Perkmann & Walsh, 2007; Schaettgen & Werp, 1996). Over the past two decades, many universities and research institutes in UK have developed institutional structures that are specifically in charge of handling every aspect of knowledge transfer activities(Lambert, 2003). KTOs are often able to benefit from their capacity to pool the inventions across research units and build a reputation within universities. While agents such as KTOs will reduce the uncertainty problem, still there is a high probability of inefficient outcomes due to the coordination failure. In the transformation from research to entrepreneurial university, the KTOs' role expands from a narrow focus on intellectual property protection to a broader role in the innovation system(Jain & George, 2007). Main indicators of this change include the movement of the KTO from periphery to the core of the entrepreneurial universities through organizational restructuring, and the change of faculties' attitudes towards knowledge transfer from a merely tolerated activity to an encouraged and prestigious academic task (Wright et al., 2004a).

3.4.2. The emergence and development of university KTO

As mentioned above, the university knowledge transfer involves multiple stakeholders, usually including the government, university administration, researchers, business and knowledge intermediaries, who work together as a value network. These stakeholders, having a variety of objectives and different resources, work with each other to achieve their mutual targets. In this sense, the boundaries and responsibilities for fulfilling knowledge transfer target are blurred (Etzkowitz, 2003b), the institutions are power-dependent and resulting networks are therefore somewhat autonomous and self-governing. In the knowledge transfer network, there is no centralised institution capable of directing and administrating the entire system, hence the traditional way of

directing or controlling such network seems not work effectively (Chapple et al., 2005; Feller et al., 2002b; Phan & Siegel, 2006; Thursby & Kemp, 2002), which calls for a fragmentation style of coordination and external dependence.

As the main establishment of university in conducting the knowledge transfer missions, the university KTOs are playing the role as the governing body to coordinate and align the knowledge transfer stakeholders and processes. University KTO is originated from the evolution of entrepreneurial university and the third stream of university activities(Graff, Heiman, & Zilberman, 2002; Macho-Stadler et al., 2004). In the UK over the past two decades many universities and research institutes have developed institutional structures that are specifically in charge of handling every aspect of knowledge transfer activities. The specific institutional arrangement has varied greatly ranging from university controlled off-campus technology brokers and technology incubators for university spin-offs, to university-managed units integrated with the overall university administration system. KTO in its broadest sense has emerged as an important player within universities and generally plays a central role in identifying technologies with commercial potential, assisting researchers to patent their inventions, packaging the technology appropriately so as to attract industry, developing strategies to market such technologies, and leading the licensing negotiations with potential licensees(Allan, 2001; Etzkowitz, 2003b; Sampat & Nelson, 1999). In the transformation from research to entrepreneurial university, the KTOs' role expanded from a narrow focus on intellectual property protection to a broader role in the innovation system. An indicator of change is the movement of the KTO from the periphery to the core of the academic enterprise through administrative restructuring and change in attitude among faculty and administrators of knowledge transfer from a merely tolerated activity to an encouraged and prestigious academic task(Wright et al., 2004a).

Despite a general positive trend in entrepreneurial activities of the universities and reported increase in the number and size of universities with KTOs, there has been suggestion of insufficient scale and intensity of knowledge transfers, with the link between science and innovations(Debackere & Veugelers, 2005). Thursby and Kemp(2002) found substantial evidence of persistent inefficiencies across universities. The main area of growth in commercial activities from universities according to Thursby and Thursby (2002) has been patent applications rather than disclosure of invention. Besides, these links are associated with geographical restrictions (Audretsch,

Keilbach, & Lehmann, 2005; Jaffe, 1989). Some researchers such as Mowery et al (2004; 2003) have gone far enough to argue that the KTOs are not only superfluous to effective knowledge transfer but are impeding the free flow of knowledge from university to industry. Nelson(2001) has argued that companies were well aware of what was coming out of university research without any advertising or pushing from university offices. In these cases, the holding of intellectual property rights by the university is unlikely to have facilitated knowledge transfer, but rather probably made it more difficult by imposing positive transaction costs on firms that wanted to further develop that technology. Feller et al (2002b) suggest that a mix of dissatisfaction with existing arrangements on one hand, and a perception of unrealized opportunities in knowledge transfer offices on the other hand exists. Universities now have to deal with the consequences of incomplete success in terms of increasing patent and licensing activity and revenues and also continuing questioning about the scale of the net benefits from their effort.

While various aspects and variables of university knowledge transfer and in particular KTO have been extensively researched, a more general question could still be imposed in regard with the position of KTOs in the university knowledge transfer system and in relation with the emerging changes and new paradigms across the industry, business, and communities. This positioning issue and question is about how the KTOs have responded to the requirements from the emerging innovation systems and the new demands from business and community. This question entails a high level of complexity which has remained under researched (Rothaermel et al., 2007). Most of the factors Rothaermel et al (2007) have summarised in their review of literature on KTO such as offices' systems, structure, and staffing, as well as the different mechanisms of knowledge transfer, nature and stage of technology, faculty, university system, and environmental factors have been receiving increasing attention. A significant factor in understanding the role, position and functioning of the KTO has been the definition or characterisation of the KTO. For instance while most of the works on the KTO have been based on an understanding that the KTO is a gateway for university inventions, some have argued that a KTO's main role is establishing a link between the university and industry (Debackere & Veugelers, 2005; Jones-Evans et al., 1999; Siegel et al., 2003a), and even more limiting views which some others suggest that scientists in universities and industry are embedded in the same formal and informal networks(Colyvas et al., 2002). Study of implications of KTO structure by scholars

(Bercovitz et al., 2001; Feldman & Desrochers, 2003; Markman et al., 2005) revealed that the choice of organisational structure influences KTO performance through the shaping of the flow of resources, reporting relationships, degree of autonomy, incentives, and commercialisation strategy, study of structures and the attitudes of KTO officials. In addition, Bercovitz et al (2001)and Feldman et al (2003) also found that KTO significantly influences the shaping of formal and informal relationships in the university knowledge transfer.

3.5. Understanding efficiency and effectiveness

In the previous literature review, some main features of entrepreneurial university have been identified: universities are playing more important roles in the national and international systems of innovation. New roles are now being considered in defining the university mission as a result. The five element model of research, education, knowledge exchange, and regional and global development is a recent development(NESTA, 2007). Changes in the global socio-economic systems and situation have led to new priorities and policies, as the result of which university economics and models of incentive for generation of knowledge have evolved to adapt to the emerging circumstances and become a viable and reliable institute for governing the public based sources of knowledge to transfer to industry and community. The KTO to stand the new challenges of the new economy needs to not only deal with the issue of performance and successful economic results but to reposition itself within the new principles and emerging business models of innovation systems ensuring a compatible achievement. The model is constituted of two dimensions of operational performance and strategic achievement. The first dimension relates to the aspects of performance of the KTO and the issues which define the collective success of the university knowledge transfer. A classification of the KTO is suggested based on three levels of performance and then the factors defining a successful structural picture of KTO are discussed. The second dimension focuses on the strategic aspects of the KTO achievements and effectiveness in the view of open innovation perspective.

3.5.1. Efficiency

Main stream of literature on the subject advocates structure and strategy as the key variables in this regard. Stressing this Feller et al. (2002b) suggest that a KTO's overall performance depends on three main elements of ability to coordinate its activities with

other agents and units, ability to process information both within and with outside the university (information asymmetry resolution), and effective alignment of incentives pertaining to stakeholders. They found that fostering these attributes to a great extent relies on the organisational forms or types adopted, from centralised to decentralised. Similarly Debackere & Veugelers (2005) in addressing the lack of attention to the organisational structure of knowledge transfer activities find three elements as critical to effective fostering of university knowledge transfer and commercialization. They suggest organizational balance between centralization and decentralization within academia, appropriate incentive structures, and appropriate decision and monitoring processes within the KTO to bring about the desired status. They summarise the studies of university industry relationship and KTO by proposing a governance structure based on decentralization, the creation of proper incentives and pooling of critical specialized resources to deal with university knowledge transfer. Three factors are introduced as the building blocks of the governance structure including appropriate organizational structure, processes and context within the university to channel academic R&D toward exploitation. The structure provides the required incentive and organizational mechanisms translated into effective processes, which are focused on knowledge management and new venture creation, which in turn need to be embedded in a supportive context of institutional and policy environment, the culture and the history.

3.5.2. Effectiveness

The second issue involves how the effectiveness of the KTO should be interpreted to fit the environmental changes. KTO strategies have frequently been limited to its legal decisions, particularly pertaining to intellectual property and transfer arrangements, and studies on processes and routines have been limited to their identification and general impact on KTO performance (Rothaermel et al., 2007). Organisations are increasingly relying on external sources of knowledge and engage in open innovation (Chesbrough, 2006b). The organisational unit for innovation is now turned to be interconnected networks rather than single firms (Coombs, 1996; Powell, Koput, & Smith-Doerr, 1996), and formal and informal links between organizations pertaining to these models of innovation work as network relationships rather than 'arm's length', transactional market links (Perkmann & Walsh, 2007). The concept of 'open innovation' has already received attention by the knowledge transfer community, and evidence showed some influence of the concept in the related communities' views, approaches and even policy and

practical recommendations (EIRMA, 2005; Lambert, 2003). This partly roots in the fact that open innovation advocates have explicitly referred to universities as key sources of IP and technology for adoption by innovation firms (Chesbrough, 2006b), which can be appreciated by the knowledge transfer community who are tasked with commercialising university IP. There is potentially much more to be gained from the concept of open innovation by universities and the knowledge transfer community than simply viewing open innovation as a convenient environment in which universities might increase industrial research funding and licensing opportunities, or as a means of outsourcing R&D activity to the university sector. This stems from the fact that universities, whilst having certain significant additional social functions and differing value-chains to those of a typical corporation, share certain key organisational characteristics with industrial R&D organisations.

The evolutionary transition of KTO from a state of bureaucratic administration role to one of responsive and proactive roles for the purpose of maximising the value from the university knowledge to the society and industry has experienced a rather unsmooth journey which has been highly context related as well as disparate in nature. A major question has been whether university is able to adapt to the emerging changes in its institutional context as it has done for most of its history. The literature in this area has remained silent so far with some recent attempts mainly on redefining the university industry relationships (Perkmann & Walsh, 2007). While many of the proposed frameworks and methodologies such as Debackere & Veugelers (2005), and European Commission (2001) contain elements of modern orientated organisational and structural propositions and solutions the question of how should the KTO look like in the age of open innovation needs addressing.

4. Features of university industry links

The university industry knowledge transfer delineates the process whereby new ideas embodied in academic inventions, and discoveries are transformed as they move from university to the commercial mainstream. This process usually takes place through a wide spectrum of channels (Cohen et al., 2002; D'Este & Patel, 2007), and relies on the interactions among a range of stakeholders(Stevens & Bagby, 2001), who, according to Normann and Ramirez (1993) are working as a 'value constellation' surrounding focal projects. Moreover the knowledge to be transferred could be both tacit and explicit corresponding to the business requirement (Cohen et al., 2002; Faulkner, 1994)and

disciplines of research. The contemporary university industry links and university knowledge transfer have evolved rapidly during the past 10-15 years as a result of extensive contextual changes at a global level leading to fundamental shifts and changes in policies, laws and regulations across countries and also cross borders (Hounshell, 1996; Rooney, Hearn, & Ninan, 2005; Stiglitz, 2006). These changes have had profound impacts in the shape, situation and process of university knowledge transfer(Loftus & Sillars, 2005). From a theoretical point of view I have summarised the characteristics of the new era of university knowledge transfer under three headings of multiplicity, complexity and dynamics. This will help us to identify the underpinning issues that will have effect on the management and governance of university knowledge transfer in the emerging globalised knowledge based economy becoming increasingly dominated by new concepts, business models and technologies.

4.1. Multiplicity

The multiplicity of knowledge transfer can be explained in two main areas of knowledge transfer, namely, multiple stakeholders and multi-channel processes. Firstly, considering the interorganisational connectivity of business innovation (Powell et al., 1996; Rothwell, 1994b), the organisational interaction is a critical issue as knowledge transfer benefits and is influenced by a variety of stakeholders(Siegel et al., 2003a; Stevens & Bagby, 2001). It is believed that the university knowledge transfer process is multi-stakeholder oriented, which mainly involves stakeholders such as the government, industry and university(Etzkowitz, 2003b; Etzkowitz et al., 2000; European Commission, 2003a; Leydesdorff & Etzkowitz, 1998) as 'primary' stakeholders (Kaler, 2003), and have sound relationship and great impact on the university knowledge transfer. Other stakeholders may also be present who are deemed 'secondary' stakeholders. This group includes knowledge transfer intermediaries, who are also critical for the success of knowledge transfer (Bessant & Rush, 1995; Howells et al., 1998). Stevens and Bagby (2001) analysed the key stakeholders who own, pay for, and benefit from knowledge transferred from university to business, and accordingly suggested that the university should be the nexus of coordinating stakeholders concerning the knowledge transfer process. More importantly, there is no individual institution in the knowledge transfer system capable of steering the entire stakeholder value network, which implies that the decision making needs more effort to align stakeholders' interest. Therefore the level of trust among stakeholders can be a critical issue pertaining to the multiplicity of

university knowledge transfer(Faulkner & Senker, 1995). What is worthy of noting is that the governance system of UK university industry links remains polycentric(Grady & Pratt, 2000). The Office of Science and Technology was created in 1992 specifically to enhance and coordinate policy on science and technology and a minister was given specific Cabinet responsibility for this area, however the responsibility for science and technology education resided with the Department for Education and Employment. The Ministry that facilitated the communication between the governmental, educational and industrial institutions was the Department of Trade and Industry (DTI) and an assortment of private and public organisations also had significant influence on the UK knowledge transfer sector at this time.

Secondly, there is an increasing attention to the recognition of a wide spectrum of channels for exploiting university knowledge (Agrawal, 2001; Cohen et al., 2002; D'Este & Patel, 2007; Debackere & Veugelers, 2005; Schartinger, Rammera, Fischer, & Frohlich, 2002) whereas the conventional focus is on the technology commercialisation through licensing (Lach & Schankerman, 2003; Thursby & Thursby, 2002; Thursby & Thursby, 2007) and spinout (Clarysse et al., 2007; Druilhe & Garnsey, 2004; Lockett et al., 2003; Wright et al., 2004b). The categorisations of these channels are also suggested to reflect the mechanism in the university knowledge transfer systems. Cohen et al (1998; 2002) examined the industry's perception regarding the importance of particular channels of university knowledge transfer. They suggested a list of channels including patents, publications, meetings and conferences, information channels, hires, licenses, joint ventures, consulting, contract research and personal exchange. Debakere and Veugelers (2005) defined the university industry links as different types of interactions between the industry and the science sector that are aimed at the exchange of knowledge and technology, and listed five types of links, namely, start-up of technology-oriented enterprises, collaborative research, contract research and know-how based consulting, development of Intellectual Property Rights, and human resource mobility. Schartinger et al (2002) proposed sixteen types of 'knowledge interaction' between business and university. In their research, they categorised these interactions into four groups based on degree of formalisation, the suitability for transferring tacit knowledge and the degree to which they are based on personal contacts. Meyer-Krahmer and Schmoch(1998) ranked the eleven types of university industry interactions from the academics perspective. According to a survey they argue that the collaborative research and informal contacts were the most important interaction types between university and

industry. The 'third stream' initiative initiated by UK government also encourage four types of university knowledge transfer activities: formation of university spin-out companies, licensing of university technology to industry, academic collaborations with industry and contract research, and human resource development and exchange(HEFCE, 2006). Additionally, the relationships pertaining to the university industry links also attracts great concerns. Perkman and Walsh (2007) studied seven types of university industry links , which focus on the relational perspective that exists behind the university industry links. Notably, in practice these channels are not mutually exclusive. In fact, in many cases some channels are combined together or embedded into other channels to achieve specific missions. For instance, within some technology licensing process, the academics also need to offer the consultancy service to facilitate the business' usage of their technology.

4.2. Complexity

The university knowledge transfer channels exhibit a variety of characteristics, and accordingly the relevant processes display complex modes (Pavitt, 2005). In some cases, the processes are triggered by university. As depicted by Siegel et al (2004) the process of licensing starts from the scientific discovery through evaluation of technology, patenting, negotiation, until the licensing to business at the end. Similarly Thursby and Thursby(2005) explained the licensing process starting from the academic disclosure and facilitated by knowledge transfer offices. On the other hand, the processes can be initiated by business, such as the contract research in which the knowledge transfer is usually 'pulled' by business but mainly managed by university where the information exchange is dynamic and complex. Importantly, these processes cannot be seen as linear processes, as they contain overlapping and recursive activities, involve multiple stakeholders and various interactions. Etzkowitz(2003b) argues that the interaction between linear and reverse linear dynamics results in the emergence of an interactive model of innovation. The linear model of knowledge transfer is transformed into an 'assisted linear model' as technology generated in academia is transferred by licensing offices as IP and through the formation of firms in incubator facilities. The reverse linear model, starting from industrial and social problems provides additional starting points from new research programmes and discipline formation.

Moreover, the diversity in institutional organisations and context has also generated high levels of complexity for the organisational aspect of university knowledge transfer. As

the main organisational establishment by university in facilitating knowledge transfer, the university knowledge transfer office's role has expanded from a narrow focus on intellectual property professional service to a broader role in the innovation system. An indicator of change is the movement of the university knowledge transfer office from the periphery to the core of the academic enterprise through administrative restructuring and change in attitude among faculty and administrators of knowledge transfer from a merely tolerated activity to an encouraged and prestigious academic task(Wright et al., 2004a). Nevertheless, the knowledge transfer offices display distinct formations of organisations in line with the institutional context and chosen goals. For example, in terms of chosen goals, Lita Nelsen, head of the knowledge transfer office at MIT, arguably America's most successful research institution, says: 'I think a specific office with clear authority of IP is critical. Only then can the organisation learn and improve. Too much dispersion of responsibility leads to confusion on the part of industry, and makes it impossible for the organisation to learn and grow from its experience.'(Loftus & Sillars, 2005), in contrast to the MIT model, many university knowledge transfer offices in the UK have taken on broader missions(HEFCE et al., 2007). With respect to the context, in different countries, the university knowledge transfer offices have various formations in line with their government policy and university's strategy (Conesa, Castro, & Zarata, 2005; Jones-Evans et al., 1999).

The development of entrepreneurial university has also led to the complexity of knowledge transfer transactions. Firstly, the involvement of intermediaries causes complexity. Evidence reveals that some universities have their patenting and licensing outsourced to external commercialisation partners(Library House, 2006), which increases the amount of communication and complexity of financial arrangement. Secondly, the development of university spin-out (Clarysse et al., 2007; Wright et al., 2007) required more intensive communication among more stakeholders, and raised more issues to be addressed, such as equity ownership, the capital raise and the need for more expertise knowledge (Lockett et al., 2003).

4.3. Dynamics

The complexity and multiplicity also reflect the dynamics of the knowledge transfer system behaviour. The university knowledge transfer is dynamic considering that knowledge has different degrees of codification, and its transfer has multiple channels(Agrawal, 2001; Cohen et al., 2002), in the interaction between a range of

stakeholders(Siegel et al., 2003a; Stevens & Bagby, 2001), as well as run through complex processes(Harman et al., 1997; Hsu & Bernstein, 1997). The dynamics of university knowledge transfer exhibits in three aspects, namely, the inter-organisational relationships among multiple stakeholders involved, the processes dynamics, and the changes in knowledge over the time. In term of inter-organisational interactions, the university transfer system could be considered as networks of relationships between its stakeholders who collaborate with each other engaging in knowledge transfer activities (Stevens & Bagby, 2001). The knowledge transfer system therefore can be tagged with inter-organisational connectivity, which highlights the limitation of the traditional static view of knowledge transfer.

Secondly, the dynamics of knowledge also influences the university knowledge transfer processes. As mentioned before, the university knowledge transfer has multiple channels and the processes, that usually exhibit dynamic characteristics(Rothaermel et al., 2007), have recursive and iterative processes(Friedman & Silberman, 2003) in which feedback loops are common (Bercovitz & Feldmann, 2006). Additionally the decision-making in knowledge transfer is not a one-way process. Especially, in relation to the university spin out, the processes are always of high dynamics(Pérez-Pérez & Sánchez, 2003), and maybe influenced by dynamics of knowledge transfer teams as well (Clarysse et al., 2007).

Furthermore, since the knowledge flows in the knowledge transfer system take a variety of forms such as tacit and explicit knowledge, the university also needs to consider the issue of knowledge changeability. These transformations could occur owing to some factors such as the requirements of stakeholders, obligation imposed by regulations and constraints of capabilities. To address the dynamic of university knowledge transfer, the university knowledge transfer management should be capable of reducing and managing the complexity and variability by increasing responsiveness and flexibility across involved functions through provision of supervision, decision-making mechanisms, and coordination of activities.

5. Summary

This chapter offers the theoretical and contextual background for preparing and executing the research presented in this thesis. The literature review tracing the historical roots of the science technology interactions, evolution of the entrepreneurial

universities, government policies and initiatives concerning the university knowledge transfer, and emerging innovation theories, laid the ground work for understanding the governance mechanism of the university knowledge transfer system. Moreover, the main issues of extant research in university knowledge transfer such as the channels and institutions are reviewed for further comprehension of the roles, significance and barriers pertaining to university knowledge transfer office in this system. Finally, by discussing diversity, dynamics and complexity of the university knowledge transfer system, the literature review identifies the main challenges the university knowledge transfer system encounters.

CHAPTER III. METHODOLOGY

1. Introduction

This chapter presents the methodologies and relevant methodological issues utilized in this research. Corresponding to the viewpoint that research questions are steering the entire research, methodologies are considered to be capable of assuring the research procedure is consistent to the proposed research questions, and the quality of the research is warranted. In line with the research questions and framework presented in **Chapter 1**, the procedure of conducting this research is designed into four steps: review, define, investigate, and remodel. The 'review' step takes account of the research on the extant works that are relevant to this research. This is essential in order to offer the theoretical perspective for the entire research. The extant works include academic research, government and business reports, and provisional interviews with specific people who have rich knowledge and experience concerning this research. The outcome of the 'review' step contains the systematically organized contextual and theoretical framework for this research, as well as more importantly the identification of the voids in the extant works.

In the 'define' stage, the boundary of research is drawn and research questions are explicitly defined. Moreover, the methodological issues such as the epistemological considerations, selection of methodologies, sampling, data collection and analysis procedures as well as the evaluation of research quality are analyzed and defined at this stage. Following the 'define' stage, the main work in the 'investigate' stage is to conduct the empirical study including data collection and analysis such as the site visit, interviewing, documentation review, questionnaire design and distribution as well as the data organization, display, and interpretation. The fourth stage is to 'remodel' the research outcome from the 'investigate' stage and the theoretical perspective built in the first stage. An in-depth and further analysis is carried out in this stage to combine the previously conducted studies with the development of theoretical understanding built in the 'review' stage. These interlocked four stages are illustrated in **Figure 3** which delineates the methodological procedure of the research.

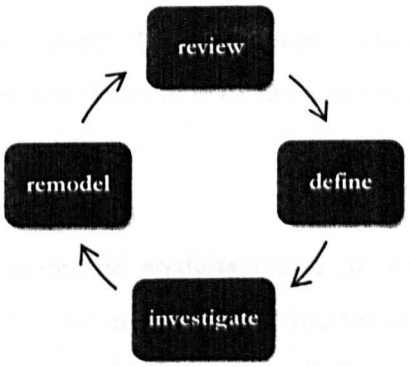


Figure 3 Steps of research

This chapter is organized as following: first of all, to ensure a strong research design it is essential to choose a methodological strategy that is congruent with the purposes of the research. This chapter therefore starts from the analysis of methodological strategy adopted in this research in particular from the quantitative and qualitative perspectives. Considering that questions of this research are exploratory in nature and the present understanding in the proposed areas is limited, this research resorts to the qualitative inquiry which corresponds with the post-positivism paradigm. This is the case as it not only can reflect the inductive nature of this research but also can indicate criteria of evaluating research quality which is different from that of positivist oriented research. Secondly, the Grounded Theory and the Q Methodology are taken into account as the two methodologies utilized in the studies to mirror the research strategies and paradigms adopted in the research. In terms of the Grounded Theory based study, this research conducted a multiple case study of 23 university KTOs across the UK. Accordingly the characteristics of Grounded Theory and multiple case study methodologies are analyzed in this chapter. With respect to the Q methodology, as this research makes use of a Q methodology based survey of leading practitioners in universities' KTOs across the UK, the procedure and the features of Q methodology are discussed here in this chapter. Lastly, the chapter covers the consideration of ethical issues and the relevant implementation process in this research, which are strictly governed by laws and university regulations.

Notably, this chapter takes the strategy of 'comparison' to explain the methodologies used in the research. This includes three main 'comparisons' namely, the epistemological and methodological comparison between quantitative and qualitative inquiries; theoretical and operational comparison between Straussian and Glaserian perspectives

on Grounded Theory; and the methodological comparison between Q methodology and conventional R methodology. Through these comparisons, this chapter aims to demonstrate the advantages and limitations of the methodologies employed in studies.

2. Qualitative inquiry

From case studies to econometric analysis much of the research published in the domain of research on university industry links and university entrepreneurship have a long tradition of employing quantitative and qualitative methodologies (O'Shea et al., 2004; Phan & Siegel, 2006; Rothaermel et al., 2007). This unsurprisingly raises the concern in regard to the selection of appropriate methodologies between qualitative and quantitative ones for certain research. Since the 1970s along with the popularization of qualitative research methodology in social science research (Denzin & Lincoln, 1994), the controversy over the relative virtues of quantitative and qualitative methodology has gained considerable impetus (Bryman, 1984; Guba & Lincoln, 1982; Hatch, 1985; Howe, 1992). Despite that the exact constitution of these two methodologies varies among various researchers with varying degrees of specificity'(Bryman, 1984), there is substantial consensus about the fundamental antinomies and their practical implications for the conduct of research(Bryman, 1984; Howe, 1992). For example, on the one hand it is widely recognized that qualitative and quantitative research are separate paradigms from Kuhnian perspective(Kuhn, 1962), each with its own set of epistemological foundations, characteristic, methodologies and goals(Becker, 1996; Guba & Lincoln, 1982; Hatch, 1985; Lincoln & Guba, 2003). On the other hand, as of technological aspects, qualitative research is like an umbrella covering a range of research methods such as grounded theory, historical method, ethnography research, participant observation and so on, which is in contrast with the quantitative methodology in social science that is usually bound to social survey. Therefore, it is necessary to take into account the distinct characteristics displayed by qualitative and quantitative methodologies at the commencing stage of the research.

The quantitative methodology is usually delineated as the approach to conduct social research. It applies the principles of natural science research to social phenomena which is generally shaped by positivism in terms of epistemology of the subject (Babbie, 2004; Lincoln & Guba, 2003). According to Guba and Lincoln(1982), positivism is 'a family of philosophies characterised by extremely positive evaluation of science and the scientific method'. They (Guba & Lincoln, 1982) also pointed out that positivistic

quantitative research methodologies are usually characterized in the methodological literature as exhibiting a preoccupation with operational definitions, objectivity, reliability, causality, and the like, as principles for positivism research. In general, surveys are usually seen as 'preferred instruments'(Babbie, 2004) for the elucidation of research that makes such epistemological reflection. Likewise in the quantitative methodology, experimental designs, modelling and secondary analyses of collected data are also often recognized as exhibiting the same underlying philosophical premises (Bryman, 1984; Kerlinger & Lee, 2000). This therefore indicates that the quality of research ought to be measured by positivist criteria such as objectivity, reliability and validity (Babbie, 2004; Kerlinger & Lee, 2000), which can be achieved by rigorously designed and conducted quantitative research. As Bryman(1984) summarized, through the quantitative research, concepts are operationalized by resorting to survey questionnaire items; objectivity is maintained by the distance between researcher and the researched along with the possibility of third party review; reliability can be carried out by employing the same research instrument in another context; and the issue of causality has been addressed by the emergence of path analysis and related regression techniques to which surveys are well suited. In this sense, research of this kind can be described as being positivist or empiricist, that is, the research of this genre is underpinned by a distinctive theory of what should pass as warrantable knowledge.

For more than four decades the so-called 'qualitative revolution' has been taking place in social science research in the context that positivism is criticized and post-positivism has been developed in the social science territory(Denzin & Lincoln, 1994, 2003). According to Creswell(1994) qualitative research 'is an inquiry process of understanding based on distinct methodological traditions of inquiry that explores a social or human problem...The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting'. it's worth noting that the qualitative methodology was traditionally developed under the positivism paradigm where researchers were trying to do positivist research with less rigorous methodologies and procedures (Denzin & Lincoln, 1994). Accordingly, in this vein, the criteria for evaluating research quality were still complying with the positivist ways of thinking (Ambert, Adler, Adler, & Detzner, 1995). However, since 1960s researchers in a number of disciplines had been acknowledging the difficulties and limitations in studying human behaviour within the confines of traditional positivist way to understand science. They argued that academic community should embrace research

that does not merely produce empirical descriptions of social phenomena but also moves towards understanding and interpreting them (Guba & Lincoln, 1982). For instance, a typical argument was made by Strauss and Corbin(1990) that the conventional canons of positivist research should be modified to accommodate the post-positivism conception of rigorous research. Likewise, Eisenhardt and Graebner (2007) also argued that forms of qualitative research can be of value for increasing human knowledge and understanding to a degree that is comparable to that attainable via quantitative methods. In short, Flick (1998) summarized these arguments using inductive and deductive dichotomy by stressing that 'rapid social change and the resulting diversification of life worlds are increasingly confronting social researchers with new social contexts and perspectives... traditional deductive methodologies are failing...thus research is increasingly forced to make use of inductive strategies instead of starting from theories and testing them'. In this regard, qualitative research is deemed to be much more fluid and flexible than quantitative research in that it emphasizes discovering fresh or unanticipated findings and the possibility of altering research plans in response to such serendipitous occurrence. Moreover, for the purposes of facilitating the comprehension of qualitative inquiry, Bogdan and Biklen (1998) offered five general characteristics of qualitative research, including 'qualitative research has the natural setting as the direct source of data and the researcher as the key instrument', 'qualitative research is descriptive', 'qualitative researchers are concerned with process rather than simply with outcomes', 'qualitative researchers tend to analyze their data inductively', and 'meaning is of essential concern to the qualitative approach'. These characteristics imply that qualitative research frequently falls within the category of exploration and interpretation rather than merely verification, and also reflect that the criteria of evaluating qualitative research are distinct from those of quantitative research. As some researchers have suggested (Ambert et al., 1995; Guba & Lincoln, 1982; Strauss & Corbin, 1990), the criteria to evaluate the qualitative study should jump out of the positivism routine. For instance, Strauss and Corbin(1990) stated that '[the criteria] require redefinition in order to fit the realities of qualitative research and the complexity of social phenomena'. It is believed that the reliance upon human variety and social complexity means that the qualitative researcher's findings always remain tentative in their generalisability, contestability and the possibility of improvement has to be accepted at all times(Strauss & Corbin, 1990). This is in line with Popper's verification principle: it is impossible to prove beyond all doubt a particular fact or proposition

(Popper, 1976). In this situation, Guba and Lincoln(1982) proposed the criteria to evaluate the quality of the qualitative research fall into four main categories, namely, the truth value, the applicability, the dependability and conformability in comparison to the typical criteria of conducting quantitative research such as the internal-external validity and reliability. This consideration of the criteria of evaluating quality of research is also mirrored in Strauss and Corbin's work on Grounded Theory (Strauss & Corbin, 1990).

It is worthy of clarifying that some researchers pointed out that it is not possible to justify quantitative and qualitative methodologies merely by epistemologies or techniques, For instance researchers like Bryman(1984) argued that it is not possible to establish a clear symmetry between epistemological positions (e.g. phenomenology, positivism) and associated techniques of social research (e.g. participant observation, social survey). A demonstration of this viewpoint is the emergence of methodological triangulation which sees the quantitative and qualitative methodologies as 'complementary rather than as rival camps' (Jick, 1979). Even from the epistemology perspective *per se*, as suggested by Lin(1998), the qualitative research methodology can be positivistic or interpretivist. In her words, the qualitative methodology can be used to document practices that lead to consistent outcome and identify characteristics and patterns that commonly pertain to different scenarios which can be found in multiple case study(say, for example Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Yin, 2009); or can be utilized to seek an understanding of the general concept and reveal the conscious and unconscious explanations people have for what they do or believe(Lin, 1998).

Given that the qualitative research differs from quantitative research significantly, in particular in terms of epistemology and techniques, it is necessary to clarify the methodologies to be employed in this research in terms of epistemological framework at the commencing stage of the study. As described in previous chapters it is obvious that research questions to be addressed are exploratory in nature. As mentioned before the general purpose of this research is set to reveal managerial situation and aspects of university KTOs in which both extant literature and practitioners show limited understanding, while elucidating the perceptions of leading practitioner in KTOs. Furthermore, this study is designed to be more than just producing empirical descriptions of phenomena but understanding and interpreting them. Accordingly this research has a post-positivist nature (Carson, Gilmore, Perry, & Gronhaug, 2001).

Therefore this research employs the qualitative methodology which is, as mentioned above, also suitable for areas where existing theory is unable to fully explain empirical phenomena (Eisenhardt & Graebner, 2007), as well as for interpreting the subjective perceptions held by people.

Furthermore, it is worth noting that this research is a phenomenon oriented research. According to Strauss and Corbin(1990) the phenomenon refers to 'the central idea, event, happening, or incident about which a set of interactions or actions are directed at managing or handling, or to which the set of actions is related'. Correspondingly, this research is designed to inductively interpret the 'phenomena' of university knowledge transfer with focus on management issues and cognitive aspects of the leading knowledge transfer practitioners' perceptions on KTOs management. Moreover, the phenomena under investigation are fairly comprehensive and complex as the university knowledge transfer system involves a wide range of stakeholders; meanwhile it rests on a spectrum of channels and polycentric government policy. In response to this complex and polycentric situation, this research selected the simplified means by taking KTOs as the target of analysis, which is regarded as the key player in the system and a representation of the working mechanism of the university knowledge transfer system (Jones-Evans et al., 1999; Macho-Stadler et al., 2007; Sampat & Nelson, 1999). Additionally, given that qualitative research embraces a wide spectrum of methods such as ethnographic study, the grounded theory and historical method, etc, in selection of proper methods this study follows Trow's (1957) suggestion that 'the problem under investigation properly dictates the methods of investigation', through which the Grounded Theory and Q methodology are employed in two sections of empirical study respectively.

3. The Grounded Theory

As mentioned before the first empirical study of this research adopts Grounded Theory as the methodology in conducting the data collection and data analysis. Considering there is controversy regarding Grounded Theory and that it has been in a state of ongoing spiral development, and therefore has divergent strands of views, it is necessary for this research to explicitly identify the most appropriate version of the method in terms of methodological strategy, procedures and evaluation, to which the following sections intend to attend and discuss.

3.1. The emergence and development of Grounded Theory

Grounded Theory emerged as a result of Glaser and Strauss's sociological research programme on dying in hospitals in late 1960s(Glaser & Strauss, 1966) when qualitative research methodologies started to gain a strong position in social science research (Charmaz, 2000; Strauss & Corbin, 1990). In 1967, Strauss and Glaser published a book(Glaser & Strauss, 1967) titled 'the Discovery of Grounded Theory', which is viewed as the cornerstone of initiation of Grounded Theory. According to authors, the book was written to explore 'how the discovery of theory from data – systematically obtained and analyzed in social research – can be furthered' (Glaser & Strauss, 1967), which is seen as the essence of Grounded Theory. In this sense, Grounded Theory 'offered a general model for constructing new theory and some foundational research operations'(Locke, 1996). Grounded Theory is usually regarded as the bridge between theory and data from inductive perspective as Strauss and Corbin(1990) define it to be "the one that is inductively derived from the study of the phenomenon it represents". In a similar way, Glaser(1992) defines it as 'a general methodology of analysis linked with data collection that uses a systematically applied set of methods to generate an inductive theory about a substantive area'. During the period of its emergence, Grounded Theory was seen as revolutionary because it challenged the then-dominant hypothetical-deductive model in social science research rather than developing a theory and then seeking out evidence to verify it. Grounded Theory is utilized by researchers to systematically gather data and inductively develop the theory derived directly from the data, and in this way it bolstered the development of the qualitative methodologies in management research(Denzin & Lincoln, 2003). In view of that Grounded Theory has three main merits: it is useful for developing new theory or fresh insights into old theory; it generates theory of direct interest and relevance for practitioners; and it can uncover micro-management processes in complex and unfolding scenarios (Locke, 2001), which meets the methodological needs of this study.

The nature of grounded theory is controversial due to the contention that grew up between the two originators (Jones & Noble, 2007; Kelle, 2005). Following their joint publication in late 1960s, Glaser developed the theoretical aspect of Grounded Theory in his 1978 book "Theoretical Sensitivity", while Strauss developed a more pragmatic approach in his 1987 book "Qualitative Analysis for Social Scientists" (Charmaz, 2000). The differences between them became more explicit with the publication of Strauss and

Corbin's (1990) book titled as "Basics of Qualitative Research: Grounded Theory and Procedures and Techniques" and Glaser's (1992)[2] polemic response to it. In the book by Strauss and Corbin(1990), the authors argued that grounded theory should be of verification and legitimately influenced by researcher's existing ideas, through which they suggested a 'coding paradigm' to explicate the construction of theoretical frameworks necessary for the development of empirically grounded categories, in which they maintain that all kinds of literature can be used before a research study is begun(Strauss & Corbin, 1990). In contrast, Glaser(1992) insisted that data must be acquired without 'forcing' it into pre-existing framework pathways, as he contended that 'categories emerge upon comparison and properties emerge upon more comparison. And that is all there is to it". He also argued 'there is a need not to review any of the literature in the substantive area under study' (Glaser, 1992; Kelle, 2005). This debate indicates a problem concerned by researchers who use the Grounded Theory, i.e. although the two originators had jointly stated 'the researcher does not approach reality as a *tabula rasa.* He must have a perspective that will help him see relevant data and abstract significant categories from his scrutiny of the data'(Glaser & Strauss, 1967, p3), it remains ambiguous *how* a theoretically sensitive researcher can use previous theoretical knowledge in generating theories from data (Kelle, 2005). Against this divergence, both originators proposed their solutions respectively. Glaser offered "theoretical coding" whereby researchers resort to *ad hoc* theoretical codes and coding families which they find suitable for the data under investigation provides a strategy applicable for a greater variety of theoretical perspectives. In comparison, Strauss and Corbin(1990; 1990) proposed a more practical and less complicated way of carrying out Grounded Theory research. They drew on a general model of action in the light of pragmatist and interactionist social theory (Annells, 1996) to build an "axis" for developing grounded theories by suggesting the 'coding paradigm' that consists of four rigorous steps, namely "conditions", "interaction among the actors", "strategies and tactics" and "consequences"(Strauss & Corbin, 1990), which can be used explicitly or implicitly to structure the data and to clarify relations between codes.

Additionally, Grounded Theory is seen as a methodological spiral that begins with Glaser and Strauss' original propositions and continues today(Annells, 1996). Recently, another influential stream of extension of Grounded Theory, the so-called

[2] This reference is cited in Kelle, U. 2005. "Emergence" vs. "Forcing" of Empirical Data? A Crucial Problem of "Grounded Theory" Reconsidered. **Forum: Qualitative Social Research,** 6(2).

Constructivist Grounded Theory has been developed and utilized in social science research(Charmaz, 2000). This stream of Grounded Theory is featured as it accentuates to 'construct' theory from researcher and participants interactions, that is, it keeps the researcher close to the participants through keeping their words intact in the process of analysis, and hence maintains the participants' presence throughout the research(Mills, Bonner, & Francis, 2006), which reflects the postmodern constructivism conceived by researchers(Annells, 1996). Albeit this research does not track the Constructive approach of Grounded Theory, its emphasis on the interaction between research and the researched is regarded with significant value in this research.

This research follows the Straussian approach, which is underpinned by three reasons. Firstly Straussian approach allows much more proactive researcher's involvement with the research methodology and influence over the data, which corresponds to the postpositivist qualitative characteristics of this research. For instance, Strauss and Corbin (1994) have clearly stated that they do not believe in the existence of 'a pre-existing reality is out there. To think otherwise is to take a positivistic position that . . . we reject . . . Our position is that truth is enacted' (p. 279). As such their proposition enables an analysis of data and a reconstruction of theory that is richer and more reflective of the context in which participants are situated(Mills et al., 2006). Secondly, the Straussian approach maintains proactive attitude towards the use of literature. Strauss and Corbin(1998) argued that grounded theorist should proactively engage with the literature from the beginning of the research process, and identified many uses for existing information, interweaving the literature throughout the process of evolved grounded theory as complementary resources contributing to the researcher's theoretical reconstruction. In this research, the literature review plays a significant role in supplementing the theoretical perspective building and data collection and analysis. And thirdly, the Straussian approach provides a pragmatic and operationalized means for researchers to follow, as Strauss and Corbin stated '[their approach] provides a cluster of very useful procedures – essentially guidelines [and] suggested techniques' (Strauss & Corbin, 1998, p4) and their "coding paradigm" model is used "to think systematically about data and to relate them in very complex ways"(Strauss & Corbin, 1990, p99).

3.2. Procedure of conducting the Grounded Theory research

As abovementioned, one salient feature of qualitative research is that qualitative

researchers are concerned more with research process rather than merely in results. Likewise, the processes of data collection and analysis are regarded as the core of Grounded Theory. Corbin and Strauss (1990) argued that the procedures of grounded theory are essential to develop a well integrated set of concepts that provide a thorough theoretical explanation of social phenomena under study, among which 'coding' from data is viewed as a fundamental analytic tool that could lead to emergence of grounded theories from the field of inquiry. By this token, the Grounded Theory methods present a series of systematic, yet flexible guidelines for collecting and analyzing qualitative data to construct theories "grounded" in the data themselves (Strauss & Corbin, 1990; 1994).

According to Glaser and Strauss(1967), the grounded theory approach should combine two data analysis processes. In the first process, the analyst codes all data and then systematically analyzes these codes to verify or prove a given proposition. In the second process, the analyst does not engage in coding data *per se* but merely inspects the data for properties of categories, uses memos to track the analysis, and develops theoretical ideas. Glaser and Strauss(1967) stressed that neither of these processes could properly accomplish the goal of generating theory from data. Consequently they suggested a hybrid approach to data analysis: 'One that combines, by an analytic procedure of constant comparison, the explicit coding procedure of the first approach and the style of theory development of the second' (Glaser & Strauss, 1967, p102). At the operational level, both Glaser and Strauss proposed the data analysis procedure based on their interpretation of Grounded Theory (Walker & Myrick, 2006). In line with the research strategy aforementioned, this research takes the stance of Straussian version, which Strauss and Corbin (1990) proposed as the 'coding paradigm' that covers conditions, interactions, strategies, and consequences. The coding in their words is defined as the 'operations by which data are broken down, conceptualized and put back together by new ways', which is viewed as the core procedure to build theory from data. The Straussian version coding procedure consists of three types of coding, namely, open coding, axial coding and selective coding (Strauss & Corbin, 1990). In detail, open coding is the initial close, line-by-line or word-by-word examination of the data for the purpose of developing provisional concepts. Through the process of constant comparison, these concepts are collapsed into categories. In axial coding, the analysis is specifically focused on an emerging category based on the work of intertwining data in a new way after the open coding. Selective coding is discovering the core category,

systematically relating it to other categories and achieving the integration of the theoretical framework.

Along with the coding process, two concepts are of crucial importance: the theoretical sampling and the constant comparison. The theoretical sampling in Grounded Theory refers to that the sampling of research is based on the concepts that have proven theoretically relevant to the evolving theory, which differs significantly from that of long-established survey based research methodologies. In Straussian point of view, the theoretical sampling is tied with the coding process closely (Draucker, Martsolf, Ross, & Rusk, 2007), for this reason they connected specific theoretical sampling strategies to the three types of coding. They suggest that open coding requires open sampling in which data are gathered to uncover as many relevant categories as possible. Axial coding requires relational, or variational, sampling, in which data are gathered to uncover and validate the relationships among categories that have been discovered. And selective coding adopts discriminate sampling, in which data are gathered to verify the emerging theory and to further develop categories that have not been well saturated(Strauss & Corbin, 1990). In this study, the sampling is conducted complying with the principles mentioned above, through which this study is able to achieve the variation, depth of focus and flexibility that are of critical importance in assuring the quality of the research.

The Grounded Theory is frequently referred to in literature as 'the constant comparative methods of analysis'(Glaser & Strauss, 1967). The constant comparison is also deemed essential to conduct the Grounded Theory research, as Glaser and Strauss(1967) stated 'the constant comparative method is designed to aid the analyst who possesses these abilities in generating a theory that is integrated, consistent, plausible, close to the data—and at the same time is in a form clear enough to be readily...operationalized...' (Glaser & Strauss, 1967, p103). And Glaser(2002) argued the constant comparison is critical to 'enhance researchers' abilities to conceptualize and form emergent theories'. Technically, Strauss and Corbin(1990, p84) suggested several comparison techniques used in the Grounded Theory research, i.e. the flip-flop comparison, the systematic comparison and the far-out comparison, which not only outline *'how'* to compare, but also point out *'what'* to compare in order to gain further and in-depth thinking from data. In the Grounded Theory based emperical study of this research, constant comparison is also playing a core role. Not only are the flip-flop comparison and systematic

comparison used in the coding steps, but also the comparison between emperical data and literature is constantly presented in the research.

3.3. A multiple case study

For the purpose of inductively building theory from the Grounded Theory, the case study is adopted as a methodological strategy for data collection and analysis in this research. According to Yin(2009), case studies are in-depth empirical investigations of particular instances of a phenomenon within their real-life context, and are usually based on a variety of data sources. In terms of the functions, Fidel(1984) indicated that the case study 'attempts, on one hand, to arrive at a comprehensive understanding of the event under study but at the same time to develop more general theoretical statements about regularities in the observed phenomena', to which the logic of this research is adhering. Case study research is viewed by many as a rigorous and empirical valid method for theory building efforts(Yin, 2009), and importantly it can be by and large consistent with the principles of Grounded Theory. For instance, the case study based theory building process occurs via recursive cycling among the case data, emerging theory, and extant literature. (Eisenhardt, 1989; Eisenhardt & Graebner, 2007), which is consistent with the constant comparation strategy, and the coding procedure of Grounded Theory. Moreover, considering that central to building theory from case studies is replication logic (Eisenhardt, 1989; Yin, 2009)and the multiple-case study exhibits the features in reflecting the logic of replication, this research adopts the multiple-case study as the methodology to conduct the empirical study. Additionally the multiple-case study reflects the 'constant comparative' principle of Grounded Theory, which deepens the understanding and explanation of the targeted phenomenon through examination of similarities and differences across cases. Additionally, as a typical scenario the multiple-case study often intends to form 'categories' or 'types' within which cases share certain patterns or configurations(Miles & Huberman, 1994). This tread is systemically designed and followed in this research.

With respect to the multiple-case methodology, three factors are considered to be of significance in conducting this research. These are namely, the data source, the contrast between variable-oriented and case-oriented, as well as the unit of analysis. Firstly the multiple-case study intends to provide a rich and vivid portrait of specific phenomenon, which demands the utilization of multiple sources of data that are considered to be capable of enriching the data and reducing the bias caused by single source of data.

Apart from the interviews conducted in each case study, this research also takes into account other data sources such as KTOs' publications, webpage information and observation etcetera. Secondly, the case-oriented study considers the case as a whole entity, looks at the parameters of the cases and then carries out the comparative analysis on cases. This is significantly different from the variable-oriented research that places the focus on variables rather than cases. Lastly, with respect to the case study research, the definition of unit of analysis is essential because it serves as the 'target' of the study, can indicate the boundary of the entire study, and accordingly can accurately reflect the research questions. As aforementioned this study treats the management issues of university KTOs as the unit of analysis. Therefore based on the theoretical sampling principle, this study selected 23 university KTOs across the UK to collect data regarding the managerial issues, such as the strategy, decision making, and capability etc.

3.4. Computerization: the utilization of QSR Nvivo 8

Qualitative data analysis endeavours to organize and reduce the data gathered into categories or essences, which, in turn, can be fed into descriptions, models, or theories(Miles & Huberman, 1984a). It usually involves systematic and sometimes time-costing management of complicated data sets. In response to this challenge, recent development of information and computer technology offers a variety of excellent solutions for the qualitative social research(Babbie, 2004), among which the QSR Nvivo has gained wide recognition. Initially named as NUD*IST (Non-Numerical Unstructured Data Indexing Searching and Theorizing)(Richards & Richards, 1994), the software was developed in 1981 and evolved to its eighth version until recently. From the qualitative research perspective, Nvivo offers three main functions for organizing, displaying, and analyzing data, which include the code-search-retrieve, data linking, and model building (Miles & Huberman, 1984a; Richards & Richards, 1994). The code-search-retrieve function assists researchers to break text down to segments or chunks (nodes), attach data with segments, as well as search and display all instance of coded segments. The data linking function enables researchers to establish links among parts, such as the field notes, nodes of interview transcripts, as well as memos etc. This function is critical as it can contribute to the revelation of relationships between codes. Lastly and most importantly, the model building function aid researchers to clarify their ideas via logical relationships and rules, and eventually develop certain regularities of the studied phenomenon.

The QSR Nvivo involves three main steps in the procedure of research, namely, coding, query, and model building which correspond to the data analysis procedure mentioned in the Grounded Theory. The coding function is the typical data reduction process of open coding, and the query can be seen as the data display process that assists the axial coding. Accordingly, the model building is the function to support the selective coding, that is, to reveal the relations between core codes and other codes. The general process of using QSR Nvivo in this research is illustrated as **figure 4** shown as below.

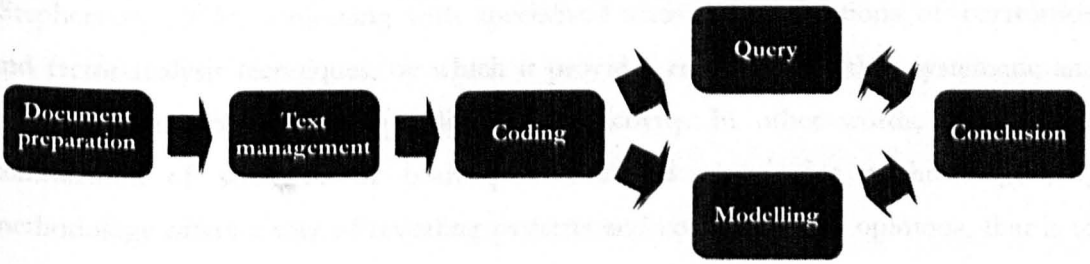


Figure 4 Procedure of conducting NVIVO 8

4. Q methodology

For the purposes of investigating the subjective perception of leading knowledge transfer practitioners, the phenomenological approach to Q methodology is utilized in this research, which is regarded as a useful methodology to systematically study subjectivity(Brown, 1996). Although the Q methodology has a long history in academic research, it remains in a status of 'fugitive' in social science research community(McKeown & Thomas, 1988). What is more, it also exhibits some unique features distinct from conventional methodologies, hence it is useful to explain the background, features and procedures of the Q methodology in brief.

4.1. Overview of Q methodology

Q methodology was initiated by British Physicist-Psychologist William Stephenson in his letter to *Nature* in 24 August 1935 regarding the inversion of techniques of factor analysis(Brown, 1980). After nearly 20 years, in his book titled "The study of behaviour: Q-technique and its methodology", William Stephen(1953) provided a comprehensive expression of Q methodology, which underpins the further development of this methodology. The utilization of Q methodology has also been expanded, as it was originally applied in the field of psychology, then spread in the fields of communication and political science, and more recently has been adopted in the behavioural and health sciences(Brown, 1996; Brown, 1980).

Q methodology was proposed as the means for the systematic study of subjectivity that is defined as the person's viewpoint, opinion, or attitude on any matter of personal and/or social importance(McKeown & Thomas, 1988). As Barry and Proops(1999) stated the Q methodology attempts 'to analyse subjectivity, in all its forms, in a structured and statistically interpretable form'. Methodologically, Q-methodology is seen as the bridge between the qualitative and quantitative methodologies (Brown, 1980) because it encompasses a distinct set of psychometric and operant principles (Stephenson, 1953), conjoining with specialized statistical applications of correlation and factor-analysis techniques, by which it provides researchers with a systematic and rigorous means of examining individual subjectivity. In other words, through the combination of strengths of both qualitative and quantitative methodologies, Q methodology offers a way of revealing patterns and connections in opinions, that is to say, Q methodology engages with the establishment of systematic patterns by identifying individuals who share perceptions, gives a structure to subjective opinion and has the potential to uncover insights into major social groups' view in terms of behaviour responses, rather than the more traditional approach which uses social-demographic categories.

4.2. Why utilizing Q methodology: characteristics of Q methodology

The reason for adopting Q methodology as one of the principle methodologies in this research roots in its unique characteristics and the purposes of this research. In this thesis, the characteristics of Q are exhibited by the two sets of comparisons given below.

Firstly, characteristics of Q methodology can be elicited by comparing it with the conventional variable oriented correlation and factor analysis methodology (R-methodology in Stephenson's words). There are two discerning factors that set Q-methodology apart from R-methodology (Steelman & Maguire, 1999; Stephenson, 1953). The first is the subjective nature of Q-methodology versus the objective nature of R methodology. In Q-methodology, all of the statements contributed by participants would be subjective, which in the Q-methodology is referred to as 'self-referent' subjectivity. In this sense, there would be no right or wrong answer; rather participants are requested to rank-order the collection of statements to reflect their personal views. In this regard, the Q-methodology also exhibits the nature of post-positivism. In contrast, the R-methodology relies on the positivist thinking towards the study of

objective variables. The second is the nature of the correlation and clustering that occurs with Q-methodology versus R-methodology. Unlike the R methodology, which is concerned with patterns across variables, Q-methodology is concerned with patterns of subjective perspectives across individuals, that is to say, in the Q-methodology, the individuals are treated as variables and traits are regarded as the cases, hence, Q-methodology implies the correlation and factoring of persons whereas R-methodology implies the correlation and factoring of traits. Additionally, the Q methodology determines the factors by factor score instead of the factor loading mostly used in R methodology. Additionally, the results of a Q methodological study can be used to describe a population of viewpoints and not, like in R-methodology, a population of people. In this way, Q can be very helpful in exploring tastes, preferences, sentiments, motives and goals, the part of personality that is of great influence on behaviour but that often remains largely unexplored. Another considerable difference between Q and R-methodology is that Q does not need large numbers of subjects as does R-methodology, for it can reveal a characteristic independently of the distribution of that characteristic relative to other characteristics (Exel & Graaf, 2005).

Secondly, as mentioned in Chapter 1, this research is set to investigate the 'managerial cognitive' issues related to university knowledge transfer. Various approaches have been used to represent managerial cognition. For instance the cognitive mapping is one of the methodologies that are frequently used to capture an individual's view on a particular issue (Tegarden & Sheetz, 2003). An analysis of various cognitive mapping techniques shows that most of the techniques may be viewed as consisting of three major parts: 1) eliciting concepts; 2) redefining concepts; and 3) identifying relationships between concepts (Tegarden & Sheetz, 2003), which is essentially based on the analysis of the relationships between concepts subjectively defined by researcher. Comparatively, Q methodology exhibits several special characteristics which make it more suitable to this research: 1) in the Q-sorting process, it requests the participants of the research 'positively' consider the research questions instead of passively answer them; 2) in Q-methodology, the concepts or perspectives are defined and interpreted based on the statistically rigorous factor analysis, by which researchers can capture organizational cognition via integration of individual cognitions; 3) no relationships between concepts are required, instead the focus is placed on interpretation of perspectives.

4.3. Procedure of Q

Q allows participants to provide their perspectives by sorting items, typically statements related to the topic into a forced Gaussian distribution which is determined by the researcher. The core of the Q methodology is the Q sorting, which helps to quantify the subjective understanding that subjects have about the concept under investigation. Based on previous research outcome, the literature review and provisional interviews, the Q methodology starts from design of appropriate statements (Q set) which pertains to the research questions, and selection of appropriate participants (P set). The designed statements are organized as survey questionnaire and sent to participants for rank-order in the form of normal distribution (Q Sorting). The analysis of the sorted statements is based on the factor analysis and essentially on the qualitative interpretation. In short, the procedure of conducting Q methodology based research can be divided into three stages: firstly the qualitative design stage that involves the design of statements and participants sampling, secondly the quantitative analysis stage that utilizes software (e.g. PQMethod in this study) to generate factors, and lastly, the qualitative interpretation of the results from the second stage. The detailed procedure of conducting Q is presented as below.

4.3.1. Sampling

Specific sampling principles and techniques used in survey research are not necessarily relevant to sampling in Q-methodology considering the contrast in research orientation and purpose. In Q methodology based research, the collective group of participants is referred to as person-sample or P-set. In principle, the participant selection can be governed by theoretical (persons are chosen because of their special relevance to the goals of the study, or purposive sampling) or by pragmatic (anyone will suffice, or convenience sampling) considerations. According to McKeown & Thomas (1988), the purposes of Q is to study intensively the self-referent perspectives of particular individuals in order to understand the lawful nature of the human behaviour, which can be achieved without large sample. Therefore the Q methodology tends to be using the small sample and theoretical sampling. Accordingly, this study selects the P-set through the search of KTO practitioners with specific attributes including the practitioners' positions in KTO, as well as the KTO's location, size and age.

4.3.2. Development of Q set

The Q-set is a collection of stimulus items that is presented to respondents for rank-ordering in a Q sort (McKeown & Thomas, 1988). The development of Q-set is based on the understanding of the concourse which refers to the flow of communicability surrounding any specific topics. The concourse could be a set of opinions, plans, questions, or even photographs. According to Brown's(1993) 'key primer' of Q methodology, the concourse should be both 'representative' and 'comprehensive'. Following this principle, McKeown & Thomas(1988) summarized that the mechanism of developing the Q-set has two facets: first, the statements could be 'naturalistic' that are drawn from communication with research participants, or 'ready-made' which come from other sources such as publications, letters, websites, previous focused-group interviews. Items from both sources can be hybrid statements. This research designs the statements mainly in the hybrid way. The second facet is that the design could be 'structured' or 'unstructured'. The unstructured design, in the words of McKeown & Thomas(1988), refers to the design that items presumed to be relevant to the topic at hand are chosen without undue effort made to ensure the coverage of all sub-issues, which is likely to have some issues under- or over- covered. Therefore, this research adopts the 'structured' design method that composes the statements systematically and seeks to avoid the aforementioned weakness in the 'unstructured' design method.

4.3.3. Data collection and analysis: Q sorting and PQMethod 2.0

In this study, the data collection mainly involves the Q sorting technique. Q sort refers to the procedure to rank-order into a predetermined forced distribution rather than rating items individually as in Likert type scale. Along with the Q survey questionnaire, the step-by-step instruction was sent to assist participants to rank-ordering the statements in the normal distribution sorting sheet. Q sorting has two obvious advantages: first is the symmetrical normal distribution allows those rank-ordered sorts from each subject have the same mean and standard deviation thereby fulfilling the statistical requirements for homogeneity of variance needed for the adoption of correlation and factor analysis. Secondly, Q sorting decreases research's bias as relevance and intensity of participants' perceptions about statements are attributed by participants who sort the statements to model their own point of view, not that of researchers (Dennis, 1986; McKeown & Thomas, 1988).

After the completion of the Q sorting, the software of PQMethod 2.0 was utilized to analyze the data collected. The freeware of PQMethod 2.0 was developed specifically for facilitating the data analysis of Q methodology based research, which offers rigorous means to organize, display, and analyze data in consistent with the principle of Q methodology. The PQMethod 2.0 runs the statistical data analysis to generate correlation matrix, expected factors and relevant parameters on which the interpretation is based. Importantly, in the interpretation stage, researcher departs from the quantitative statistical procedure and revisits the qualitative realm. Furthermore, in the interpretation stage, the comparison between literature and research results is taken into account to generate rigorous and robust interpretation.

4.4. Evaluation of Q research

Due to its qualitative aspects, questions of research validity in Q-methodology are assessed differently from that in quantitative research methods. Validity in Q methodology refers to the ability of subjects to 'accurately share perspectives about the phenomenon under investigation and to the researcher's ability to accurately elucidate and describe the perceptions expressed'(Dennis, 1992-1993). In Q methodology, content validity of the Q-sample is addressed by thorough literature review and by eliciting expert advice of those associated with the field under investigation. Furthermore, item validity, as understood in more traditional survey research, does not apply to the study of subjectivity. In Q-methodology, one expects the meaning of an item to be interpreted individually. The meaning of how each item was individually interpreted becomes apparent in the rank-ordering and in follow-up interviews. Importantly, the Q-sorting operation is totally subjective in the sense that it represents participants' points of view. There is no external criterion to appraise an individual's perspective. Each individual's rank-ordered set of statements is considered a valid expression of opinion. Additionally, some qualitative approaches are often utilized to strengthen validity in Q methodology, including verification from literature review, follow-up interviews of research participants, as well as information from experts and focused groups.

Q methodology has been described as robust and reliable (Brown, 1996; Brown, 1980; McKeown & Thomas, 1988). The reliability of Q-methodology has been proven through test-retest studies and assessment of reliable schematics. For test-retest reliability, studies have shown that administering the same instrument (Q sample) to the

same individuals at two points in time have typically resulted in correlation coefficients of 0.80 or higher (McKeown & Thomas, 1988), which indicates methodological stability when studying phenomena that do not change rapidly over time. Q-methodology has also produced consistent findings in two more types of study comparisons: first, when administering the same set of statement to different person samples; and second, when pursuing the same research topic, but using different sets of statements and different person samples. For reliability and stability of identified opinion clusters, findings were consistent when the instrument was administered to different person samples, and even when different Q samples and person samples were used.

Regarding the generalisability, since most Q-methodology studies are exploratory and qualitative in nature and tend not to use random sample designs, generalizations rarely occur beyond the immediate set of participants and are typically not based on the numerical distribution of study participants among factors. The value of Q-methodology rests in uncovering valid and authentic opinion clusters and does not occur beyond the immediate set of participants. Once identified, their prevalence among the larger population can be subsequently tested using large group surveys and standard variance analytic methods. The purpose of a typology is not the creation of an exhaustive classification scheme but to find something in the material worthy of classification, and to provide some of the categories.

5. Ethics issues

One of the most appealing features of research is the degree of freedom: on the one hand researchers are free to pursue exciting opportunities, exchange ideas freely with peer researchers, and are free to challenge conventional knowledge. On the other hand it implicates the potential deficiencies in dealing with ethical issues concerned by a variety of stakeholders involved with the research activities. The consequence of such deficiencies can be far-reaching: in addition to the physical, psychological, and/or economic harm that may befall individual participant, a belief in integrity of science and scientist may be deteriorated or even destroyed(Loue, 2000). Researchers have been aware of this problem in the research practice. Miles and Huberman (1994) stressed '[researchers] cannot focus only on the quality of knowledge we are producing as if its truth were all it counts. We must also consider the rightness or wrongness of our actions as researchers in relation to the people whose lives we are studying, to our colleagues and to those who sponsor our work'. Notwithstanding, the exact guideline or

code for ethical issues concerning social research, in particular the qualitative research, remains relatively ambiguous due to the individualized and non-systematic approaches adopted in some research, and the unpredictability pertaining to the data collection and analysis (Miles & Huberman, 1994). In response to this challenge, researchers have proposed general theories for identifying and handling the ethical issues at different stages of research. For instance, Flinders(1992) offered an ethical framework containing four views of ethics: utilitarian, deontological, relational and ecological, to accommodate with different stages of research procedure.

In light of Flinders' idea of research ethics together with the research methodologies employed, this research takes into account three main elements of the ethical issues, namely, the informed consent, anonymity and confidentiality, as well as the avoidance of harm, which are consistent to the 'utilitarian' view of ethics(Flinders, 1992) and the assessment criteria of University of Liverpool Management School. The informed consent emphasises the importance of accurately informing the subject of this research regarding the nature if the research and obtaining participants' verbal or written consent to participate. The first empirical study adopted the interview as the main data collection method. Correspondingly the verbal consent had been explicitly obtained from every participant. With respect to the Q methodology based study, the data collection and analysis are based on the questionnaire, and the participants were invited voluntarily to participate, therefore the return of the questionnaire was seen as the written consent. As far as the anonymity and confidentiality concerned, considering the research covers the management aspects of the KTO which might involves some level of business secrecy, all the data collection and analysis process are under strict control by research, and accordingly all the information is confined in the use of this specific research. In terms of protection from harm, this research assessed the interview questions and Q questionnaire questions to avoid any emotional uncomfortable. Apart from the self-assessment of the ethical aspects of this research, the research proposal, interview questions, questionnaires, and cover letter had been sent to the University of Liverpool Management School Research Ethics Assessment Committee for review and consequently awarded with official approval to conduct the research.

6. Summary

This chapter offers a comprehensive discussion of the methodological issues to be used in this research and points out the direction of using these methodologies in the

research. The significance of this chapter rests on three aspects: firstly, it shaped the entire research in terms of the epistemology and methodology. Considering the research questions are exploratory in nature and the phenomenon under investigation is complicated, both Grounded Theory and Q methodology are employed as the core methodologies to reflect the postpositivist and qualitative inquiry embedded in this research. Moreover, the procedures and evaluation criteria of this research are also presented in line with the purposes and methodology strategy of this research. Secondly, this chapter identified the appropriate approach from the controversial strands of Grounded Theory. Although the fundamental logic of the Grounded Theory is clear, the interpretation and actions to conduct the Grounded Theory based research are distinct because the Grounded Theory is still experiencing the so-called 'spiral' development and several influential strands have accordingly been emerging. Against this backdrop, this research adopted the Straussian version of Grounded Theory as it not only complies with the epistemology and methodological strategy of this research, but also affords this research with the practical and systematic guidelines. Thirdly, this research takes into account the ethic issues embedded in design, conduct and report processes, which not only assure this research has the comprehensive consideration of the key ethical issues concerning the entire research, but also enriches the understanding of the quality of research.

CHAPTER IV. AN EXPLORATORY STUDY ON MANAGERIAL ISSUES OF UNIVERSITY KNOWLEDGE TRANSFER OFFICES IN THE UK: RESEARCH DESIGN AND IMPLEMENTATION

1. Introduction

This chapter contains the research design, data collection and analysis of a multiple case study research conducted to examine the emerging landscape of university KTO management. The study aimed identifying features of university KTO management in the context of the popularisation of the open innovation paradigm and entrepreneurialization of the university. The Straussian version of Grounded Theory methodology (Corbin & Strauss, 1990; Corbin & Strauss, 2008; Strauss & Corbin, 1994) is adopted in this study to facilitate collecting, analyzing and interpreting the comprehensive set of qualitative data collected via interviews with practitioners and examination of documentations. In line with the research objectives proposed in **Chapter 1** and the structured procedure of conducting Straussian version of Grounded theory research, this chapter consists of three sections. The first section presents the research objectives and develops the research framework of the study on the basis of the value chain paradigm. In the second section, the data collection of the research is analyzed and presented. Finally presented is the analysis processes of Grounded Theory study including three stages namely open coding, axial coding and selective coding (Corbin & Strauss, 1990).

2. Research objectives

In line with the research question mentioned in **Chapter 1**, this section explains the research objectives of this study. As discussed in previous chapters, the existing evidence of applications of new approaches to university knowledge transfer (Feller et al., 2002b; Leitch & Harrison, 2005) has been double edged. On one hand these new development have been in favour of knowledge transfer from university to wider community, on the other hand doubts have been cast over the efficiency of university knowledge transfer in terms of the impact of university research on innovation in industry. The policy sector in Europe and the UK have shown concern too (European Commission, 2003a; Lambert, 2003). In particular the concerns are directed towards the question of how university knowledge transfer could be managed and governed in the context of the transformation

of innovation models to open innovation and the entrepreneurialization university. These concerns can be related to a number of aspects such as: 1) the need for further understanding of university knowledge transfer mechanisms, such as channels and institutions, to accommodate the emerging innovation environment (Perkmann & Walsh, 2007), 2) although businesses still view universities as slow-moving, bureaucratic and risk-averse, many universities have improved significantly in management decision-making and devolving responsibility to academic and administrative managers rather than committees (Lambert, 2003), while there is still scope for improvement, and 3) the efficiency of KTOs in coordinating stakeholders' knowledge transfer activities and aligning their interests in such context, in particular from a management perspective including strategy, process, organizational structure, as well as skills and capabilities (Bercovitz et al., 2001; Debackere & Veugelers, 2005; Feller et al., 2002b; Siegel et al., 2003a).

The development of KTOs, which is viewed as a representation of university entrepreneurship paradigm shift, has been a matter of concern of many knowledge transfer stakeholders. A more specific question can therefore be posed with regard to the effectiveness and efficiency of university KTOs in response to the emerging changes and new paradigms across the university, business, and communities. That is, how do KTOs respond to the requirements from the emerging innovation systems and the new demands from business and community? Existing empirical research showed that it is not just a question of size, location and structure of the office or competence of the staff (Chapple et al., 2005; Phan & Siegel, 2006; Siegel et al., 2003b), but it may be about a proper understanding of organizational practices and emerging innovation theories that could be applied to university knowledge transfer. It also could be attributed to the major difference in the clock-speed of the two sides, university and industry, which raised the question regarding the issues of effective communication between the two sides and efficient mechanisms of coordinating their activities. It is believed that part of the solution is in a better understanding of KTO's development in the context mentioned above, particularly in terms of the effectiveness and efficiency as discussed previously. The issues of effectiveness and efficiency lead the focus of this study to the management practice of KTOs. Therefore the objective of this study is to reveal the current situation of university KTO management in the context that both universities and their innovation environment are in a state of transition towards a modernised interpretation of knowledge exchange.

3. The conceptual framework

Previously, in order to achieve a better understanding of the university knowledge transfer and organizational practices, the existing literature was discussed and demonstrated that the attention should be paid to 'management' aspects of university knowledge transfer. However, management of an organization could be a very complex and broad issue. In the light of the 'knowledge value chain' model proposed in **Chapter 2**, and the extant research regarding the organizational practice of KTOs this study resorts to the value chain model to systematically disaggregate the management of KTOs and examine its key components.

the value chain model proposed by Michael Porter (1985), which has been widely recognized as a useful framework to understand and analyse strategy and operations, describes the activities within and around an organization, and relates them to an analysis of competitive strengths of the organization. It evaluates which value each particular activity adds to the organizations' products or services. This idea was built upon the insight that an organization is more than a random collection of resources, people and capital. Only if these things are arranged into systems and integrated with systematic activities it will become possible to produce something of value to customers. The value chain model disaggregates an organization and systematically examines all the discrete but interrelated primary and secondary activities that the organization performs. Along with the process, the value chain model also identifies some other key management elements of an organization, which include strategy, infrastructure, and human resources.

As a special organisation within the university, KTO generates value by facilitating the knowledge flow from academic researchers to users. This unit has certain organizational characteristics as a business organization, and therefore the value chain model can be applied to the analysis of KTO. In this study, the people and platform elements are considered as equivalent to secondary activities, and processes to represent primary activities of the chain. By the same token, the strategy leads the suggested value chain as the 'outcome' of the value chain model as illustrated in **Figure 5**.

To provide an underlying theoretical framework for studying the emerging landscape of university knowledge transfer, a conceptual model is proposed based on the value chain paradigm consisting of four main factors: strategy, people, process, and platform. These

are also the elements regarded as most relevant headings for determining the effectiveness and efficiency of university KTOs. These dimensions are consistent with the general management literature in understanding the strategic position and the operational performance of organisations. Platform relates to structural issues such as institutional policies, infrastructures, and organisational forms and relationships. People factor regards the issues that concern the human resources of the institution including incentive regimes, and professional capabilities, skills and expertise. Process is about operational aspects of knowledge production and transfer such as procedures and routine activities. These factors should be set against the institutional strategies while considering the external environment, and then be translated into functional and operational strategies. These constructs are explained further in the following.

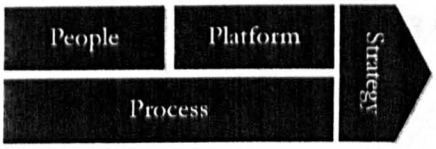


Figure 5 Value chain based conceptual model

3.1. Strategy

Strategy has been defined in many different ways for different purposes (Mintzberg, 1987b). Henry Mintzberg (1987b) summarized multiple definitions of strategy into five Ps, namely plan, ploy, pattern, position, and perspective, and analyzed how these definitions interrelate. In addition he also considered the need for strategy to set direction, focus and effort, define the organization, and provide consistency (Mintzberg, 1987a). In this study, the strategy of KTO management is understood as the 'position' of the organization. According to Mintzberg (1987a), the 'position' focused strategy refers to "the mediating force ... between organization and environment, that is, between the internal and the external context". As far as the position based definition is concerned, the KTO's strategy aims to locate the KTO in the system of knowledge transfer. From this angle, the strategy of KTO covers issues such as directions, roles and missions.

KTO's strategy is shaped by key stakeholders' interests and strategies pertaining to knowledge transfer. As the business antenna of university, most KTOs have been reported to embrace multiple business models of knowledge transfer in order to

maximize the outcome of university entrepreneurial activities (HEFCE et al., 2007; Jain & George, 2007). From an academic perspective, KTOs view themselves as promoting core academic values such as dissemination of knowledge through publication and expansion of research, as well as providing assistance to faculty in obtaining research funding. In this way, KTOs not only provide professional services for academics to assess and protect the value of IP, but also motivate academics to commit to knowledge transfer (Friedman & Silberman, 2003). From the business side, as more and more businesses seek external resources of innovation (Chesbrough, 2003a; Fabrizo, 2006) KTOs can offer a gateway to facilitate the business to get access into the university territory, and more importantly to provide a platform for business and academic researchers to exchange knowledge (Hughes, 2006). Governments also value KTOs as they provide public benefits by assisting transfer of research to use. These issues are critical in defining the strategic direction of the university knowledge transfer systems and the KTO.

3.2. Process

From the perspective of KTO, the process management is centred on the conduits of transferring knowledge from university to business. As stated in **Chapter 2**, recently, there has been an increasing attention to the recognition of a wide spectrum of channels for exploiting university knowledge (Agrawal, 2001; Cohen et al., 2002; D'Este & Patel, 2007; Debackere & Veugelers, 2005; Schartinger et al., 2002) rather than the conventional focus that is on the technology commercialisation through licensing (Lach & Schankerman, 2003; Thursby & Thursby, 2002; Thursby & Thursby, 2007) and spinout (Clarysse et al., 2007; Druilhe & Garnsey, 2004; Lockett et al., 2003; Wright et al., 2004b). The 'third stream' initiative initiated by UK government also encouraged a wider range of university knowledge transfer activities: formation of university spin-out companies, licensing of university knowledge to industry, academic collaborations with industry and contract research, and human resource development and exchange (HEFCE, 2006). Among these processes, the core issue of KTO process management is to coordinate different stakeholders' knowledge transfer activities (Litan, Mitchell, & Reedy, 2007). In this sense, KTOs also take on the responsibility of marketing university knowledge, building relationship with business and mobilizing academics to engage in technology commercialization. In addition as mentioned in **Chapter 2,** from the value chain perspective the process also should consider implementation process of

knowledge transfer, such as the stage-gate process which was summarized as acquisition, processing and dissemination in **Chapter 2.** In this study, the process of university knowledge transfer, therefore, will focus on two main streams including the decision-making process, and the process pertaining to various channels of knowledge transfer such as licensing, consultancy and spinout.

3.3. Platform

Regarding the KTO management, the platform refers to the combination of infrastructure and organisational structure that support university knowledge transfer processes. In terms of organisational structure, Bercovitz et al (2001) suggested four types of organisational formation of university knowledge transfer which reflect the organisational structure of KTOs. A recent EU research project on knowledge transfer institutions(2004) classified KTOs into three groups, namely, department of the university, wholly owned company at the university, and independent organisations connecting to universities, which reflected different priorities by universities and KTOs. These classifications also give an account of Bercovitz's(2001) argument that different organisational structures have distinct levels of information-processing capacity, coordination capacity and incentive alignment. Importantly the structure of KTO also reflects the mechanism of communication between stakeholders and the process of decision-making of knowledge transfer. With respect to the infrastructure, there are two major issues related to it: the information system that reflects the mechanism of communication and information sharing between internal and external stakeholders, and the resource management which includes the funds allocation and facilities management.

3.4. People

University knowledge transfer involves transfer of value across entities including organisations and individuals (such as academics, knowledge transfer professionals, venture capitalist etc) with certain interests, perceptions and preferences through processes managed by professionals of various types. The role of professional individuals in setting up and running KTOs has been addressed by academics and practitioners (Allan, 2001; Chapple et al., 2005; Hoppe & Ozdenoren, 2002; Jones-Evans et al., 1999; Siegel et al., 2007; Terry, 1998). Nevertheless the communication, in particular negotiations with business requires specific knowledge and

skills which most universities in the UK are not able to sustain (Lambert, 2003). Development and recruitment of appropriate body of professionals and establishment of proper incentive systems to drive the university knowledge transfer has been emphasised in Lambert report(2003), as well as by researchers such as Wright(2007) and Siegel(2007). The Lambert Review states that developing and implementing an effective human resource strategy will be one of the major challenges for university's commitment to third stream activities(Lambert, 2003). People factor in this study covers issues concerning KTO's human resources management strategy and operations including incentive regimes (Friedman & Silberman, 2003; Markman et al., 2004), and professional capabilities and skills (Hattori, 1986; Shattock, 2003).

Theoretically, this value chain based research framework offers a strategic tool for practitioners and KTO management to understand and analyse KTOs' activities. Importantly, surrounding these four elements, the interview questions were designed (see **Appendix 2**) based on the literature review and group discussion which involves experienced practitioners and academic researchers.

4. Data collection

As mentioned in **Chapter 3** considering that the research questions are exploratory in nature, this research adopted the methodology of Grounded Theory. Case study was utilized as the method to conduct the research as they are deemed suitable for areas where existing theory is unable to fully explain the empirical phenomena (Eisenhardt & Graebner, 2007; Strauss & Corbin, 1990; Strauss & Corbin, 1994). In this study, the Straussian version of Grounded Theory was chosen as discussed in **Chapter 3**. It is important to point out that, although the Straussian version of Grounded Theory provides specific and well defined process steps for the researcher to follow, maintaining the flexibility to adapt the process and the tools according to what emerges from the data is essential to avoid subverting the entire process by adhering over-strictly to preconceived ideas (Charmaz, 2000; Corbin & Strauss, 1990; Glaser & Strauss, 1967). Therefore although the implementation of this study is delineated in a sequential format, as part of the constant comparative method (Corbin & Strauss, 1990; Strauss & Corbin, 1998), the research steps often took place simultaneously and were part of an iterative developing process. In other words data collection and analysis of this research followed in an iterative, cyclical process of typical Grounded Theory research. In addition, this study utilized interview as the main means to collect data. Most of the interview

questions were intentionally designed open-ended to elicit narrative and solid description from participants, which expectedly leaves considerable possibility for themes to emerge. The collected data were analyzed with the assistance of software named QSR Nvivo. In the following sections, salient elements of each phase will be described in detail which include sampling, interview based data collection, data security and confidentiality, data analysis and assurance of research quality.

4.1. Sampling

Two criteria have been considered in selecting samples. Firstly, as a multiple case study, the sampling of this research was aimed to generate maximum variation. Hence this study was designed to collect information on a reasonably large number of instances of KTOs in the UK. Secondly, according to the sampling principle of Grounded Theory, in this research case study participants were selected via a theoretical sampling strategy which focused on the participant-informants who work as practitioners or officers in university KTOs. Based on these two criteria, in this study 23 university KTOs were selected which represented the nexus of three important elements, namely the location of KTO, the research capability of universities, and the performance of university knowledge transfer by the measures of HEBCI survey. These three elements could assure the sample selection to conform to the criteria mentioned above.

The location is critical to KTOs strategy and activities. Bania et al (1993) argued that there is a positive relationship between university R&D and the number of start-ups in the same region. And Jaffe et al (1993)also pointed out that patents generated within a region are more likely to be cited by firms in the same region. In general as Feldman (2003) stated that research universities have considerable impact on the local economic development, this study selected the participant university KTOs representing different regions of Britain. Another critical factor influencing the KTO managerial strategy and activities and differentiates KTOs from each other is the research capabilities of their parent universities. In this research, two criteria were taken into the account, i.e. the RAE 2001 and university research funds from the government. In this research the universities were ranked at three levels according to their RAE 2001 and research funds from research councils (e.g. HEFCE). Thirdly, based on the data of HEBCI2007 that was considered to be able to represent general performance of KTOs, a cluster analysis was conducted to group universities into three levels (see **Appendix 3**). Roughly equal numbers of universities were selected from each level. The combination of these three

elements assisted to select 30 universities. Ultimately 25 KTO managers or practitioners from 23 KTOs agreed to participate in this research. The profile of this sample is illustrated in Tables from **Table 2** to **Table 7** shown in the following. It is worth noting that considering the aforementioned selection criteria the cases were expected to achieve the maximum variation of university KTOs in the UK, although from a methodological point of view these samples are not a definitive representation of universities *per se*.

Table 2 Ranking distribution of Sample Universities

Rank group	No.	Percentage	
<=3	5	19%	
3< & <=4	1	4%	
4< & <=5	5	19%	
5< & <=6	12	46%	
6+	3	12%	

Table 3 Research Funding Distribution of Sample Universities

Research Funding	No.	Percentage	
1M< & <=5M	7	27%	
5M< & <=10M	7	27%	
10M< & <=30M	2	8%	
30M< & <=50M	4	15%	
50M+	6	23%	

Table 4 Age Distribution of Sample Universities

Age group	No.	percentage	
< 1960	14	56%	
1960< <1992	5	20%	
>1992	6	24%	

Table 5 Age of KTO sampled (average: 11 years)

Age group	No.	Percentage	
<=2	2	8%	
2< & <=5	3	12%	
5< & <=10	11	42%	
10< & <=15	1	4%	
15<	9	35%	

Table 6 Profile of sample KTOs and affiliated universities

CASE	UNIVERSITY					KTO		
	REGION	AGE	RANKING	No.	HEFCE Funds (£)	AGE	No. STAFF	TYPE
1	Scotland	<1960s	5.6	23125	27867000	1998	20	Dept.
2	Scotland	1960s	4.7	9090	5020000	2001	16	Dept.
3	Scotland	>1992	1.9	12715	1019000	2002	8	Dept.
4	Scotland	<1960s	5.7	8460	5601000	2002	8	Dept.
5	Scotland	1960s	4.7	24305	9170000	1984	42	Dept.
6	Wales	<1960s	4.7	12025	34301000	1993	24	Dept.
7	Wales	<1960s	5.4	30095	80389000	1990	55	Dept.
8	England NE	<1960s	5.2	18510	30671707	2003	10	Dept.
9	England NW	<1960s	5.2	21210	26921365	1988	29	Dept.
10	England NW	<1960s	5.7	39985	68931357	1988	40	Venture
11	England NW	>1992	4.3	20100	7942186	1998	40	Dept.
12	England YH	>1992	2.2	52275	951458	1985	85	Dept.
13	England YH	>1992	3	28350	3577823	2001	31	Dept.
14	England EM	<1960s	5.3	32620	34402769	1998	50	Dept.
15	England WM	<1960s	5.3	30520	38112600	1987	34	Dept.
16	England WM	>1992	2.2	24065	705805	1985	40	Dept.
17	England WM	1960s	6	29795	27702148	2000	23	Dept.
18	England LN	>1992	2.5	22275	1461701	2006	13	Dept.
19	England LN	<1960s	6.4	12185	82441897	1992	45	Venture
20	England SE	<1960s	6.5	22640	90164963	1987	39	Venture
21	England SE	1960s	5.4	15925	16532051	2004	35	Dept.
22	England SW	>1992	1.9	15300	713101	1998	7	Dept.
23	England SW	<1960s	5.7	23360	37864321	2000	53	Dept.

Table 7 Size Distribution of KTO: Number of Staff

Size group	No.	Percentage	
<=10	3	12%	
10< & <=20	4	15%	
20< & <=30	4	15%	
30< & <=50	8	31%	
50<	7	27%	

4.1. Design of the questionnaire

The data collection of this study involved a variety of means including interviews, and documentation and public information checks. In terms of interviews, 25 in-depth interviews were conducted with managers of 23 KTOs from 23 universities across the UK. Interviews were based on semi-structured questions that had been developed through the review of literature and a series of group discussion with experienced practitioners and academics who acted as research support team.

The questionnaire for interview included 19 questions which covered strategic and managerial issues pertaining to university KTOs. The questions were grounded on the four value chain based managerial elements proposed before. The table below illustrates the source of interview questions. These questions are designed for two purposes: 1) offering a controllable framework to narrow the interview discussions 2) covering issues of relevant topics comprehensively.

Table 8 Source of questions

Managerial Elements	Question Number	Issues covered
Strategy	(1) (2) (3) (4) (5) (6) (18)	Stakeholders, role, impacts and missions of KTO, performance indicators, barriers
Process	(7) (8) (9) (13)	Channels, business models, IP management, procedure of knowledge transfer, barriers
People	(14) (15) (16)	Relationships, skills and capabilities, senior staff, people structure, barriers
Platform	(10) (11) (12) (17) (19)	Finance resource management, intermediaries, organizational structure, information system

4.2.Administration of data collection

One of the most critical issues of this study is to identity the proper interviewees. In this study, the researcher targeted senior managers of KTOs at the sample universities identified in previous **Sampling** section. Two elements underpin the selection of 'senior managers' of KTOs as the interviewees of the study. Firstly the extant research regarding the senior manager's positions in organizations which reflect the roles KTO senior managers are playing. Such research mainly include upper echelon's perspective(Hambrick & Mason, 1984) and managerial cognition perspective (Stubbart, 1989). These perspectives emphasize that the information-processing capabilities held by senior managers exert significantly on the strategy and decision making of organizations. Secondly, currently in most KTOs across the UK, the senior managers are not only serving as organizational managers to make decisions for the KTOs *per se*, but also are participating in the practice of knowledge transfer such as networking, information processing, negotiations, and so on. Hence essentially they are the bridge between the university's knowledge transfer strategy and practice. From this angle, it is obvious that senior managers of KTOs are rich sources in both knowledge transfer knowledge and experience, which would enable them to provide useful and comprehensive information as well as important insight into the issues concerned by this study.

Prior to the interview, a brief introduction to the research and an individual consent form were sent to the interview participants for review. At the initial stage of the data collection, four pilot interviews were carried out to verify the empirical operability, meaningfulness and significance of research questions. Most of the interview questions received positive comments and some of them were reworded according to the pilot interview participants' comments. Moreover, the pilot interviews offered experiences regarding the time control and voice record transcription.

Each interview took between one to two hours at participants' office. Before the interview, two conditions were clarified to assure the quality of the collected data. The first was that interviewees were asked to provide answers based on facts or real experiences rather than personal opinion, attitude or feelings. The second condition was that the researcher only explained the interview questions instead of joining the discussion to avoid influencing the interview with own viewpoints. After formal interviews, several email exchanges were made with participants to clarify some of the

questions and answers and comments were received. In addition, all contents of the interviews were voice recorded and transcribed. The entire interview based data collection took around three months.

4.3. Data security and confidentiality

All collected data were maintained in the possession of the researcher in a locked, private office. The data file that linked respondents' names to their numbers was stored in a locked file cabinet. All working files of data were identified only by the participant number. All data reported is done only in aggregated form hence no individual personal or university information will be displayed in any relevant reports. All email communications were done on an individual basis so that none of the respondents had access to contact information for any others.

5. Data analysis

This analysis of data adhered to the principles of grounded theory considering that the purpose of this research was to 'build and explore' rather than 'test and validate'. In this study, interview transcripts were analyzed and coded by utilizing QSR Nvivo 8.0 as mentioned in **Chapter 3.** The analysis followed the standard protocol for grounded theory research as described by Strauss & Corbin (1998) in a constant comparative method integrating the ideas of the participants into the development of the study. There are three stages of coding, open coding, axial coding, and selective coding as explained in the following sections.

5.1. Open coding

After transcribing the results from the narrative questionnaires and interviews, the first analysis was completing open coding where "conceptual labels are placed on discrete happenings, events, and other instances of phenomena" (Strauss & Corbin, 1990, p. 61). Strauss & Corbin (1990, p. 10) continue by stating that 'To uncover, name, and develop concepts, we must open up the text and expose the thoughts, ideas, and meanings contained therein....Without this first, analytic step the rest of the analysis and communication that follows could not occur'. In this stage a line-by-line analysis was conducted on the transcripts from the interviews by using a highlighter to show common concepts, which later became categories. For example, 'performance indicator' was a common theme in both questionnaire and interview data. Each time the

participants wrote or said something about 'performance', or 'performance indicators', the statement was referenced under that category within the respective code libraries.

In the open coding stage the interview transcripts were analyzed and coded by assigning topics or codes to segments of the text (AKA, codes). 11 main codes were identified including *impact of KTOs, objectives and goals of KTOs, performance indicators, the people structure, skills and capabilities, organisational structure, barriers and impediments, leadership, relationship with stakeholder, information sharing process, knowledge transfer channels and business models, funding management as well as motivation and incentives.*

Table 9 Literature underpins for open coding

No.	Issues	Study
1	Impact, roles and mission of KTOs	(Siegel et al., 2007), (Macho-Stadler et al., 2007), (Sampat & Nelson, 1999), (Graff et al., 2002),(Hoppe & Ozdenoren, 2002),(Jones-Evans et al., 1999), (Phan & Siegel, 2006),
2	Performance indicators	(Chapple et al., 2005), (Phan & Siegel, 2006), (Markman et al., 2005), (Anderson, Daim, & Lavoie, 2007),
3	Organizational issues: structure and culture	(Bercovitz et al., 2001), (Lambert, 2003), (Debackere & Veugelers, 2005), (Siegel et al., 2003b), (Feller et al., 2002b), (Siegel et al., 2007)
4	Skills and capabilities	(Lambert, 2003), (Rothaermel et al., 2007), (Wright et al., 2007)
5	Funding management	(Salter & Martin, 2001), (Lambert, 2003),
6	Barriers and impediments	(Siegel et al., 2003a), (Lambert, 2003), (Debackere & Veugelers, 2005), (Graff et al., 2002),
7	Leadership	(Lambert, 2003),
8	Relationship with stakeholder	(Allan, 2001), (Terry, 1998), (Siegel et al., 2007)
9	Process	(Phan & Siegel, 2006), (Siegel et al., 2003a), (Harman et al., 1997), (Major & cordey-hayes, 2000)
10	Knowledge transfer channels	(D'Este & Patel, 2007), (Meyer-Krahmer & Schmoch, 1998), (Perkmann & Walsh, 2007), (Wright et al., 2004b), (Clarysse et al., 2007), (Perkmann & Walsh, 2008), (Rothaermel et al., 2007)
11	Motivation and incentives	(Friedman & Silberman, 2003), (Markman et al., 2004), (Lockett et al., 2003)

Although the 'open coding' emphasizes the importance of 'open' analysis of the transcripts, for the purposes of guaranteeing relevance of the analysis of qualitative data, the research also considered existing literatures to help forming the 'nodes'. Table 9 above illustrates the underpinning literature of selected nodes. Details of underpinning literature can be found in **Chapter 2.** Furthermore at this stage, codes were assigned to the text without worrying about how they related to one another. Some seemed to fit a suggested category and were assigned there on a provisional basis. Examples of such provisional categories are 'organizational structure' and 'barriers and impediments'. Because questions were asked about these topics specifically, it was assumed and quickly confirmed that data would emerge in these categories.

5.2.Axial coding

The next procedure of data analysis was axial coding, which is 'the process of reassembling the data that was fractured during open coding' (Strauss & Corbin, 1998, p. 124). In this phase, categories are related to their subcategories to begin explaining the phenomena. As more and more data was collected, additional categories were added and the amount of text referenced under each category became large, making it easier to see connections among the categories and subcategories. In other words, the existing codes were examined and grouped in clusters, referred to as trees, aka Trees Nodes in Nvivo. Trees are coded to indicate a theme or grouping of ideas. Codes that could fall within the same category are assigned to the same tree. For example, the 'roles', 'missions', 'impact' as well as 'stakeholders' roles' were categorized in the Tree Node of 'strategy'. This process typically involves some coding in both directions. Sometimes a theme emerges first, and further refinement of the theme reveals that a greater level of detail exists, and more explicit codes are developed following that later. In some cases, previously assigned codes are pulled together and the tree code is assigned once it becomes clear how the concepts relate to one another. In some other cases, a code that has been provisionally assigned to one tree may be moved to another tree that better fits the concept in the light of closer analysis. All these operations were supported by Nvivo 8, where codes are referred to as nodes.

Similar to the open coding process, this is an iterative process. As themes develop, they are compared and adapted or changed to constantly best reflect the ideas expressed by the respondents. In some cases, a concept was clearly articulated in a later interview and then previous interviews were reviewed to determine if that concept was present in the

earlier interviews as well. At this stage, great care was taken to ensure that concepts and ideas were not imposed when they did not really exist. Specifically, even when it seemed that a new concept would apply to a given interview, unless specific text could be identified to which it could legitimately be assigned, it was not coded with that code. This process involved multiple iterations and examinations of text to refine the more subtle nuances of the text.

It is noteworthy that in the 'axial coding' stage this study adopted Miles and Huberman's (1984b) tabulation technique in analysing the data. Firstly, collective data set accounts for each case were generated based on the information extracted from interview transcript, notes from observation record, and public information from KTOs' websites. Based on the result of 'open coding', in this stage, the study reduced the data to form an 'unordered mega-matrix'(Miles & Huberman, 1984b), which was displayed and maintained by software of QSR NVIVO 8. In this stage, the similarities and differences among selected cases were identified and used to discover the pattern of current management of university KTOs. Through constant comparison within the mega-matrix, each KTO was compared and connected to others as categories and dimensions emerged (Strauss & Corbin, 1990). Table 10 illustrates the summary of the matrix and Table 11 presents some key examples of the citation of transcripts to support the results of this stage. The findings from this practice, in particular the underpinning transcripts are described in **Chapter 5**.

Table 10 Summary of the matrix

	Group I	Group II	Group III
Strategy	C3, C4, C1, C17, C13	C7, C18, C15, C22, C23, C1, C14, C2, C9	C16, C19, C8, C11, C10
People	C1, C12, C23, C5, C13, C16	C22, C14, C21, C6, C17, C18, C2, C2, C2, C17	C15, C7, C10, C19, C11
Process	C7, C5	C3, C1, C15, C23, C16, C18, C21, C6, C17, C14, C2, C8, C9, C13	C19, C10, C20, C19, C11
Platform	C1, C12, C3, C16, C5	C14, C22, C23, C7, C14, C18, C5, C2, C8, C9, C13	C20, C17, C19, C10, C21, C11

'C*n*' stands for the number of cases

Table 11 key examples of statements

	Group I	Group II	Group III
Strategy	The office has no explicit articulated mission. Supporting research was the main goal of the KTO with IP exploitation described as a "side effect"- C3	While the KT strategy of the university can be seen to have a strong supra-institutional focus, the primary emphasis is currently on KTPs and developing links with regional SMEs for research and placements- C22	It is a University close to its markets with processes and policies in place, especially risk management, and a UKTO fully integrated into the vision, strategy and operations (including control of projects and programmes- C16
People	Known as "the entrepreneurial university" but has lost its edge in the KTO. There is too much risk aversion and even academic enterprise is being stifled by this culture-C5	Very strong ethos of working with industry in academic departments but objectives might be personal rather than corporate- C17	Excellent business-like atmosphere. Open to new ideas and collaboration – if it increases income or makes them more effective. Their model is seen to be functioning perfectly well whether called Technology Transfer or Knowledge Transfer- C7
Process	Represented the traditional University technology transfer operation – support for research and liaison with the external world related to it. The University doesn't use the term Knowledge Transfer except with KTPs- C7	Value for money is in the eye of the beholder. Could this university be getting better value for its investment? University managers need to start benchmarking inputs as well as outputs- C17	KT models vary from the Technology Transfer Push model to knowledge Pull and the rarer opportunism - being in the right place at the right time to take advantage of early-stage influential ideas- C10
Platform	University do not act as Knowledge Management Structures; they have the knowledge and try to capture bits of it and the rest is not really managed- C16	In some ways the organisation and commitment to KT can be seen as being used to reverse academic excellence though the appointment of enterprising and entrepreneurial academic faculty- C22	It is embedded throughout the University with BDMs based in Faculties and a structure of 3 professional directors to support them and their academic staff – all answerable to one powerful Vice President- C10

5.3.Selective coding

Selective coding is the final stage of the coding process and involves the development of overarching themes throughout the data sets. Essentially the selective coding is "...selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development" (Strauss & Corbin, 1990, p. 116). This coding process took place towards the end of the analysis while the summary reports were developed for features of KTO management, and the comparative analyses were done among characteristics of all universities and KTOs. As the coding was refined main themes emerged regarding categories of data that informed the research questions. At this time, it became clear that answers to the research questions were emerging. It also became clear that rich data were emerging regarding the challenges faced which also brought this question to a sharper focus during the analysis. This is what is referred to as *theoretical sensitivity,* where the researcher must remain open, or sensitive, to the data in order to allow themes to emerge naturally (Glaser & Strauss, 1967; Strauss & Corbin, 1990). For this reason, greater care was taken with interviews to pay special attention to these themes.

As the comparison process continued predictable patterns began to emerge, which allowed the researcher to form an early interpretation of features pertaining to the university knowledge transfer system. By clustering the similarities of factors that were coded from the open coding and axial coding stages, five general existing principles were determined to form the preliminary pattern describing the university knowledge transfer. The core mission of this stage is to identify 'common' elements from the codes from open coding and axial coding. Different from the axial coding which intends to identify the differences between cases, the selective coding in this study aims to explore the 'common' features embedded in the codes proposed in the axial coding stage. In other words, the common features among 'strategy', 'processes', 'platform' and 'people'. The purpose of this stage essentially is to answer the research question regarding the 'common' features of the emerging knowledge transfer system.

To illustrate this selective coding stage, firstly a diagram is utilized to visualise the process. Strauss and Corbin (1998) state the following about drawing diagrams during the selective coding phase of the analysis: "diagramming is helpful because it enables the analyst to gain distance from the data, forcing him or her to work with concepts rather than the details of the data" (p. 153). The data analysis process is illustrated as

shown in **Figure 6**. In this diagram, the ® stands for the 'relational' codes which reflect the common characteristics in association with the elements of axial coding. In Nvivo 8, ® is represented by free nodes called 'relationship'. Through the analysis of these relational free codes, the 'features' of the knowledge transfer system emerged. This analysis is also grounded on the 'theoretical sensitivity' as suggested by Glaser and Strauss(Glaser & Strauss, 1967). Moreover, for the purpose of explicit demonstration of the process of selective coding, **Table 12** is designed to show the content of 'relational codes' which connect the managerial elements with the features founded. This preliminary pattern describing the features of university knowledge transfer system were developed based on concepts identified during the selective coding stage, as well as the comparison made with extant literature, especially a comparison of literature on entrepreneurial universities (Clark, 1998; Etzkowitz, 2003a; Etzkowitz & Leydesdorff, 2000) and the open innovation principles (Andrews, 2003; Chesbrough, 2003a).

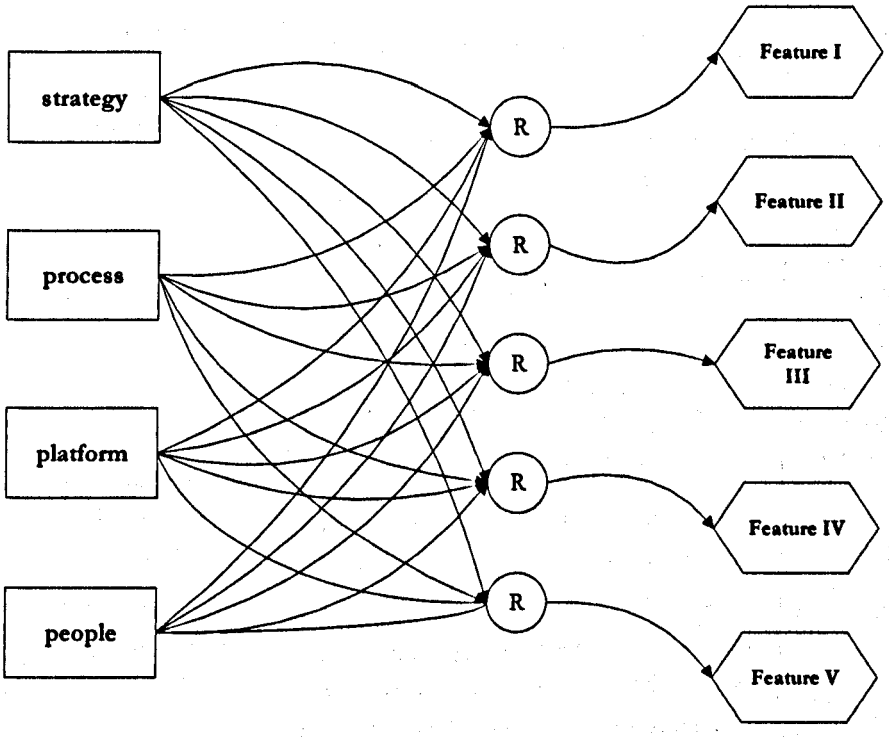


Figure 6 The process of data analysis in selective coding

Importantly, throughout the coding and data analysis process, notes and memos were recorded about observations and impressions from the interviews or reflections and interpretations achieved during the coding process. As part of the theoretical sensitivity, it is important for the researcher to continually ask questions about the data (Strauss &

Corbin, 1998) such as what does this mean? How do these items relate to each other? This approach led the researcher to revisit the data again and again to search for potential themes, which resulted in a deeper and richer understanding of the data.

Table 12 The content of selective coding

	Strategy	Process	Platform	People
Feature I	'we encourage bringing in practical help from outside or external organisation with desires, vision... As a leading edge university we encourages external partners –Venture Capitalists are partners, as are major international companies, business support organisations – and NWDA.'-C10	'Computer design dept was encouraged to engage with creative art designers to develop practical solutions for the community and SMEs'. -C5	'Do spend time commissioning top quality IT systems and believe that this was good use of time as it will save investment in posts. IT system is actually research activity oriented recording publications etc' –C13	'Trying to develop relationships with Pfizer and ICI for post-doc positions which are directly related to business applications and so enhance the focus on contract research' -C17
Feature II	The business model is non-linear, more of a virtuous circle, utilising a wide range of input from different approaches to realise value. Incentives to participate, i.e. rewards & business plan competitions –C7	'The business model varies across the activities but also from evidence of others, across the University. University policies embedded in business models were well embedded across the University eg consultancy and research funding whereas activity that was seen to be ERI specific such as company formation, was not. There seemed to be no self examination of processes but there was willingness to adopt external models' -C2	'Innovation Showcase has dedicated space to allow students to develop new ideas and generate new knowledge. Flexible space with external support, alumni role models, successful businesses in partnership.' -C4	'The important role for a business model to now, the service provided by the KTO has been personal or 'very individual' due to the select engagement, now there is a shift towards pursuing more strategic partnerships and collaborations so systematising the BM creating a leaner meaner model based on core function of the University and bringing in strategic partners to that business model as required. Commercialisation in conjunction' –C23

	Strategy	Process	Platform	People
Feature III	'Historically has been IP wastage but now the schools have become more aware of IP assets – the University has become better at recognising what is 'background or residual IP' that it must retain in order to do contract research and consultancy. University and KTO becoming smarter' –C23	'All outflow of IP is via and controlled by KTO – the Technology Transfer Team is well interfaced with industry and networks and so effective in its role to create opportunities. KTO also run internal seminars, promote successes, train new staff, new systems dissemination through web site. –C1	Resource utilised in the best way to manage the IP portfolio. (KTO does quarterly reports on how many disclosures/ spinouts. Internal review mechanism in place providing a 'strong gate'	IP wastage is not an issue for us, As everyone they go for low hanging fruit and ignore unripe or higher up stuff. The important thing was to react if offered an opportunity by the academic; implication was that it did not matter what the outcome was as long as the KTO reacted and so built a relationship which might produce easier results in the longer term. –C17
Feature IV	'Drawings on expertise of academic in outflow – academics know where IP may be best placed. It is difficult to find truly complimentary partners – academic or otherwise – but we are open to working with partners and extending its network of industrial contacts'. -C20	'we are the formal channel for commercial activities with ownership of all IP derived from the university – however we have the option to introduce external intermediaries to strengthen the knowledge transfer process...' –C15	'have not looked at any parallel models but do use market research and business planning support provided by local intermediaries and RDA' –C9	'The university currently identifies relationships as central to the outflow of intellectual property: relationships with industry and particularly SMEs which is a reflection as to the priorities of the institutions themselves. Relationships between staff and professional partners in industry – but in facilitating the university are aware as to the importance of external intermediaries.'-C6

	Strategy	Process	Platform	People
Feature V	Our performance measurement indicators mainly include: 1) Number of academics employed in KT as well as their other duties. 2) Impact measurements – know it is long-term and difficult 3) Measurement of THINGS - and separate out the different aspects of KT 4) Making an impact, visibility, regional influence where they can be measured. Please note: many of the measurements are intuitive and qualitative – have a huge influence but are difficult to measure' -C22	'Performance indicators are: 1)increase speed of process of transfer income from 2)licensing/trading 3) strengthen the flow of invention disclosures 4) Over and above these three is progress in the quality of the assets in the portfolio – are companies starting to sell product, do they have strong management teams – will their shares be floated on stock market?' –C19	'One of the most important indicators is reputation: a change of name, from "Research & Consultancy" to "Research & Innovation" within last 6 months reflects a University wide exercise to look at external perceptions. KTO was felt to project a more accurate multi-dimensional image. The change was not proposed by the Director.' –C5	'Developing skills of our academic staff is one of the missions of KTOs. …Satisfied academics – given challenging opportunities and support to fulfil them but not distractions' –C2

These R codes were selected based on the results of axial coding, but they developed the understanding of the interview transcripts via the systematically connection of axial codes. By interpretation of the common features summarised from the selective coding, the five features have been proposed and presented in **Chapter 6.**

6. Assurance of the quality of research

As mentioned in **Chapter 3,** the criteria of measuring the quality of this qualitative research are different from those of traditional quantitative research. As Denzin and Lincoln (2003) argued 'Terms such as credibility, transferability, dependability, and confirmability replace the usual positivistic criteria of internal and external validity, reliability and objectivity'. To meet these criteria, this research took several actions to assure the quality of the research including:

1) Multiple perspectives. In this study, the multiple perspectives include three elements: 1) multiple data source from both interviews and documentation, 2) interviewees are from universities with different knowledge transfer strategies and different levels of knowledge transfer development, 3) the research topics cover organizational management and general university knowledge transfer. Using these multiple perspectives allowed for the development of a more nuanced analysis of the data.

2) Thick description. Rich, thick description allows the reader to make decisions about transferability. With such detailed description, the researcher enables readers to transfer information to other settings and to determine whether the findings can be transferred because of shared characteristics. The analysis includes detailed description with quotations taken directly from participants' statements to allow readers to see and make connections for them.

3) Member checks. Lincoln and Guba (1985) consider this to be 'the most critical technique for establishing credibility'. In this study, research participants had more than one opportunity to verify and correct data as it was analyzed, coded, and reported. Respondents received transcripts of their interviews and were invited to make additions or corrections.

4) Peer review and external audit. Because this study is part of a research project, it is subject to be reviewed by an expert group including knowledge transfer practitioners and experienced academics both before and after the study. In addition, the work was supervised by an academic advisor throughout the study. This provided an external check on both process and integrity of the data and the research. In addition, all the coding process and results have been checked by another research colleague to examine the existence of a reliable match between the coding categories.

Generally speaking, issues of credibility were addressed through the peer review, multiple perspectives, and member checks; issues of transferability were addressed through the usage of thick, rich description; and issues of dependability and confirmability were addressed through the peer review, members verifications, coding check, and constant comparative process as suggested by Creswell (1994). In summary,

this study allowed for the needed flexibility of grounded theory research and paid attention to the rigor of the methodology to ensure the quality of the findings.

7. Summary

In this chapter, the design of a multiple case study as part of the thesis has been presented. For the purpose of revealing the emerging landscape of KTO management, in this chapter a research framework has been proposed by means of literature review. Based on the research framework, the interview questionnaire has been designed and study participants have been identified. Importantly this chapter explicitly presented the processes of data collection and data analysis. All the processes have followed the Straussian version of Grounded Theory.

CHAPTER V. AN EXPLORATORY STUDY ON MANAGERIAL ISSUES OF UNIVERSITY KNOWLEDGE TRANSFER OFFICES IN THE UK: FINDINGS AND RESULTS

1. Introduction

This chapter presents the findings and results of the study in a sequential way in terms of the results of coding stages of 'open coding', 'axial coding' and 'selective coding' of the study explained in **Chapter 4**. Accordingly this chapter includes three sections: 1) the results of the open coding, which mainly present a general picture of KTO management. (In this section, a quantitative analysis of KTO's performance is also included); 2) the results of the axial coding, which reveal a status of transition of KTOs and their management; 3) the results of selective coding, which explored the salient feature of KTO in the state of transition. It is important to point out that although the results are outlined in a sequential format, the study has been an iterative and cyclical process. At the end of this chapter, a discussion is presented to reflect the results of the study.

2. The general picture of KTOs' management

In the 'open coding' stage the study revealed a number of facts regarding current status of KTO management, which drew a general picture of KTO management in the UK. Firstly, for the purpose of better understanding the current status of KTO management the study resorted to the HEBCI Survey 2006-2007 (HEFCE et al., 2007). In the HEBCI Survey, a wide range of performance criteria have been covered to present a comprehensive picture of universities' performance. For the purpose of focusing on the most relevant indicators and showing a simplified picture, this study focussed on five indicators, namely, the IP income, active Spin-out income, Consultancy income, Contract Research income and Facilities and Equipment provision income. Also in addition to the conventional indicators, facilities and equipment provision factor is also selected in this study. The reason for this is that the study intends to broaden the perspective of channels of university knowledge transfer. Moreover as mentioned in **Chapter 2**, these indicators are believed to be of high relevance and representativeness to the efficiency and effectiveness of KTO. Table 9 displays the performance of selected indicators. As stated in the sampling section of **Chapter 4**, the samples of this

research were selected using multiple criteria, hence the HEBCI survey data of these selected universities provided a picture of diversity. Notably, these sample universities exhibit bias in the selected performance indicators.

Table 13 knowledge transfer performance of samples (*in £000*)

Case	contract research	facilities & equipment provision	consultancy	spinout	IP income
1	7396	185	12774	40000	1722
2	6515	0	3232	15000	1132
3	2085	15	210	0	81
4	4074	1395	569	0	297
5	6349	0	3425	9000	62
6	3700	23	3016	150	138
7	9749	0	5560	4579	1500
8	20672	2308	5484	0	370
9	11806	1449	7539	8200	197
10	24353	5126	2805	14847	475
11	1498	403	3295	7500	10
12	2621	246	1699	0	36
13	1366	0	2778	0	75
14	9134	3271	2020	4905	651
15	26229	1870	5522	3330	1295
16	1858	480	481	0	1610
17	24373	606	4273	10460	273
18	5021	449	2801	0	163
19	74975	1937	4455	41328	1968
20	63426	2804	1495	0	2984
21	12205	8970	21308	1482	96
22	1199	0	595	424	16
23	18933	243	15465	3548	697
AVG*	14762	1382	4817	7163	689
SD	18618	2176	5042	11341	785

**AVG denotes average value, and SD denotes Standard Deviation*

In order to facilitate the analysis of the performance indicators listed in **Table 9**, the study utilized the Bar Charts and Radar Charts to visualise the analysis. Generally The Bar Charts gives the comparison between KTOs in different universities in terms of individual performance indicators while the Radar Charts show the individual KTO's knowledge transfer performance in comparison to the average value of performance

indicators. Table 9 and Figure 6 show a general image of performance of these five knowledge transfer channels across the 23 KTOs. It is obvious that generally contract research and consultancy surpass other channels. This reflects the reality that most universities still focus on the 'relationship' based channels(Perkmann & Walsh, 2007). In addition, the incomes from facilities provision, the spinout as well as from IP are very lopsided to some extent. In other words, the gaps between high and low are considerable. For instance, in terms of the income from spin-out activities, the standard deviation is more than £10M. In other words, as some universities remain at the nil figure some others gained more than £10M a year. Such deviations are displayed in the following **Figures.** In the following **Figures,** the maximum value university gained from specific knowledge transfer is set as 1, and others are converted to a value proportion to the maximum income. For instance in the case of Contract Research, the case No. 19 has the biggest value, hence it is set as 1. Accordingly the case No. 23 is converted to 0.25. In this way, the general values of the income from each channel are standardized. This assists to avoid the observation bias caused by differences in absolute values. Hence the distribution as well as the comparison can be explicitly illustrated.

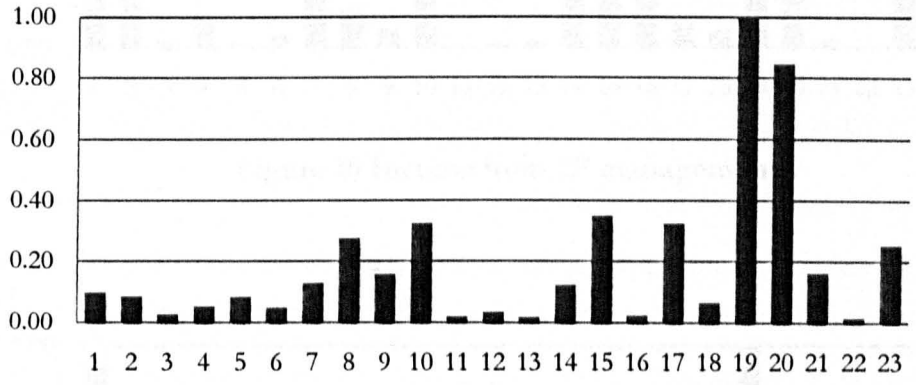


Figure 7 Income from contract research

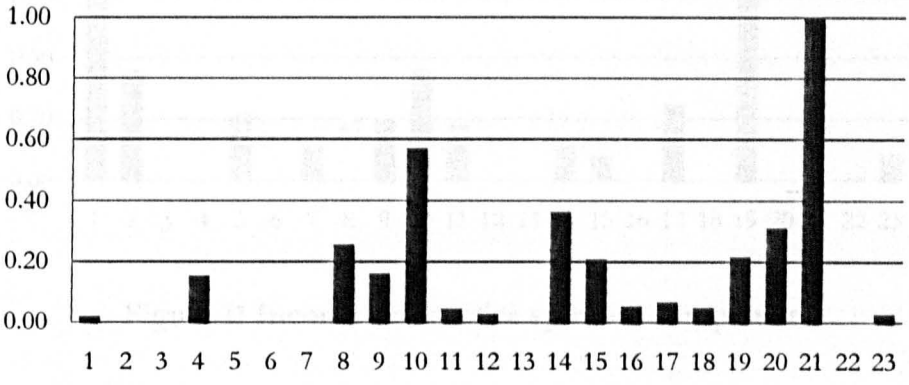


Figure 8 Income from facilities and equipment provision

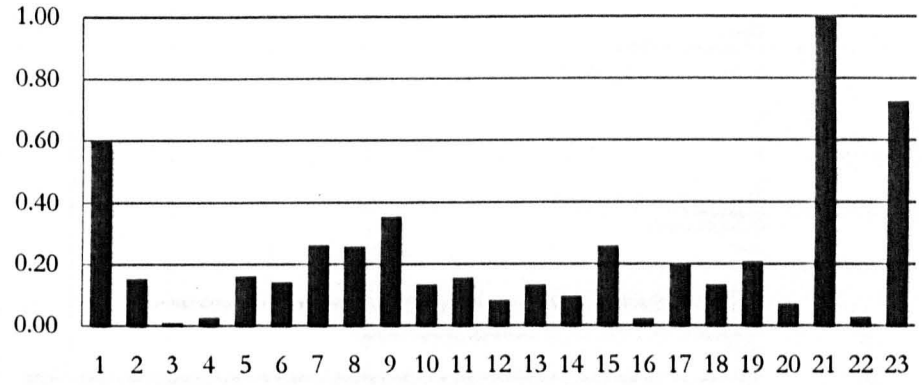


Figure 9 Income from consultancy

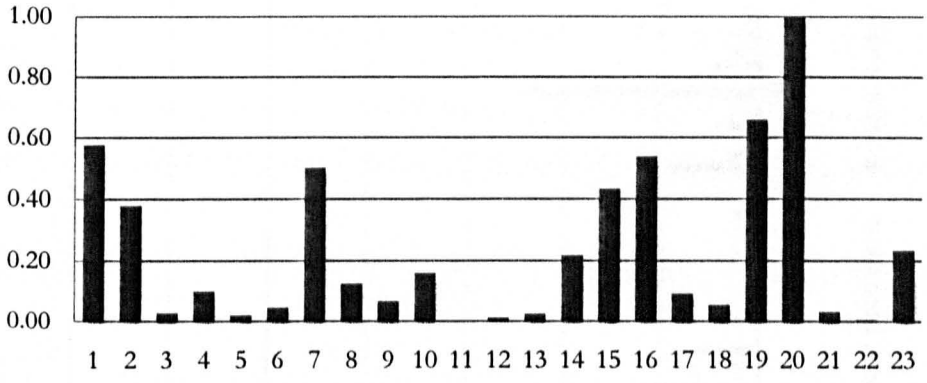


Figure 10 Income from IP management

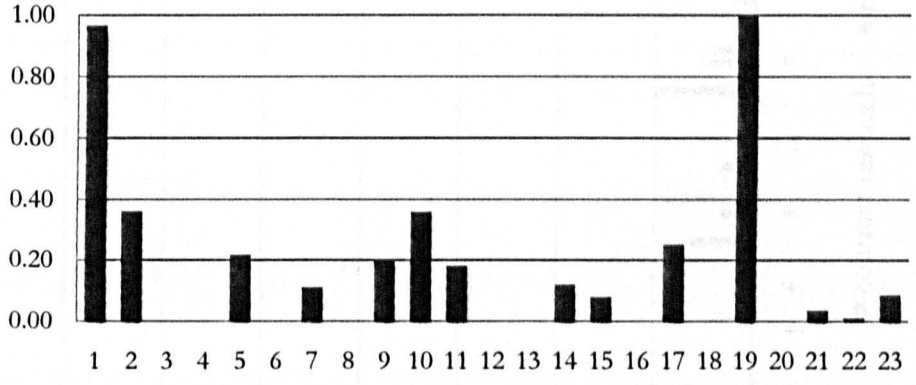


Figure 11 Income from active spin-out companies

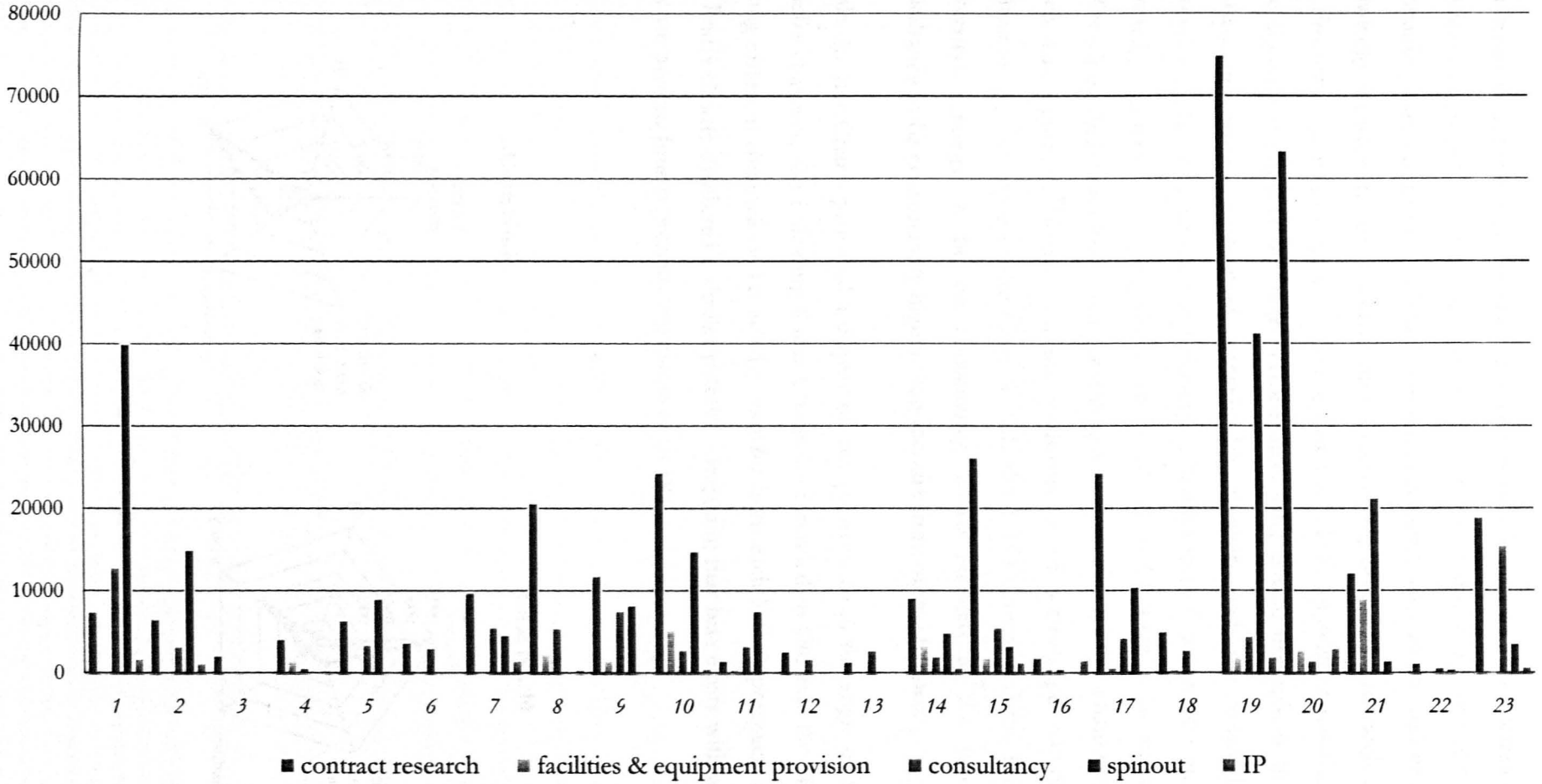
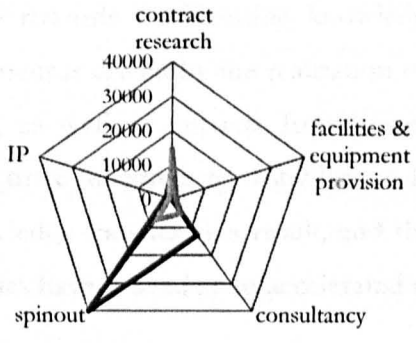


Figure 12 Performance of knowledge transfer activities by 23 KTOs (HEBCI 2006-2007)

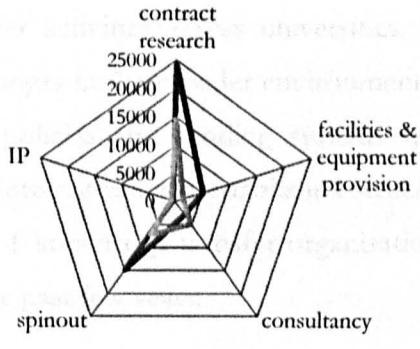
The broad knowledge transfer performance shown is Figure 11 also illustrates the main imbalance occurred between the channels of contract research and the active spin out companies. This could be attributed to various reasons, such as the university KTOs' knowledge transfer strategies, universities' location, reputation and research capabilities etc. From the interviews the study found that the KTO's knowledge transfer strategies have significant impacts on their performance. One typical example is the teaching focused universities performed considerably weaker than the research focused universities. This can reflect the Lambert's classification of universities in terms of knowledge transfer strategies, which can be found in **Chapter 2**. In addition, some KTOs set up their knowledge transfer strategies to focus on specific channels, a strategy which has significant impact on the performance of knowledge transfer of the institution. For example in the Case No 21, the KTO determined the focus of the university's strategy to be on consultancy, which resulted in the income from consultancy to be considerably higher than income from other channels.

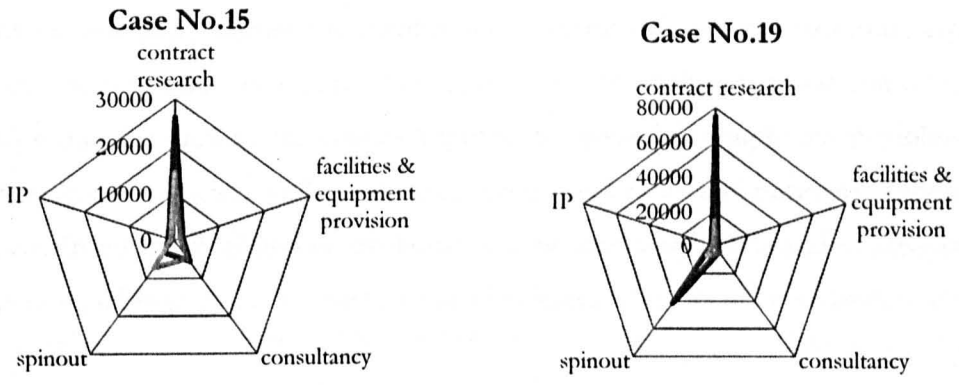
While the Bar Charts provided a display of comparisons from the angle of knowledge transfer channels, the following Radar Charts are intended to illustrate the bias existing among different channels of knowledge transfer from each KTO's perspective. Since all the Radar Charts displayed a similar pattern – meaning that bias exists within all KTO- here we present four representative charts as shown.

Case No.1



Case No.10





Note: The light gray line refers to the average value of incomes

Figure 13 Radar Charts of performance indicators of selected cases

The four representative cases clearly exhibit the diversity existing in the current state of KTOs in terms of their performance. This in turn reflects that in the context where universities are in a state of transition from traditional to entrepreneurial, the KTOs are also experiencing significant changes. Furthermore, this situation also mirrors that the imbalance and bias in KTOs are in line with the complexity existing in university knowledge transfer systems as proposed in **Chapter 2.**

While the quantitative analyses shown above presented a general picture of the complexity and imbalance existing in the KTOs performance, the following section presents the qualitative findings of the general performance of studied KTOs. The results are based on the analysis of the 12 elements coded in the 'open coding' process mentioned in precious chapter. Generally, it is believed that a transformation stage is in progress across universities in the knowledge transfer area which includes a growing tendency towards modernising knowledge transfer activities across universities. This development is driven by the realisation of the changes in the broader environment and business, as well as impacts from government policies and funding systems which together drive initiatives for establishing KTOs. Universities have established structures for knowledge transfer as a result, and the body of knowledge transfer organisation in universities have moved at an accelerated rate in the past few years.

Over the past decade most participant KTOs have restructured their organisation. In general, an evolution can be seen in the movement of the KTO from an original location as part of the research infrastructure to a relatively independent entity, and then to a part of a broader focus on innovation related activities. On the other hand the

study shows that despite a widely receptive view on new ideas across many KTOs, there is a present inconsistency across the institutions in terms of strategy, structure, type, approach, and performance which are affected by aforesaid multiplicity and complexity of knowledge transfer such as universities' reputation, research strength and disciplines, intellectual property policies, and contextual issues including environment, funding structures, etc. Importantly, abundant evidence of satisfactory scenarios and models and especially packets of best practices exist in many institutes which could be transferred to other organisations.

In general, knowledge transfer is regarded as a relatively minor part of universities' activities and their funding, and hence is viewed as a peripheral issue for many universities. Misalignment of strategy and goal incongruence is still among main problems in knowledge transfer activities. This is particularly evident in the relationship between the KTOs and policy sector, where exists a widespread criticism towards its role and behaviour particularly with regard to the funding and monitoring the knowledge transfer activities.

Institutional and structural factors including attitudes towards knowledge transfer among academics impacted by the imbalanced workload model for them (which is impacted by the incentive systems), incompatible structure and inefficient decision making processes, relatively low priority given to this branch by the senior management, and unavailable professional staff and continuous funding, are among the main issues and barriers.

Another major institutional issue is the position of the KTO with regard to its stakeholders. The study shows that KTOs' focus remains strongly on the institution itself, and their priorities are set around protecting the university's interests which includes the academics as part of the university structure. This has led to a situation, as a common theme, where the KTO takes a central role within protectionist regime frameworks. What must be noted is that another view contrary to this however exists in some units where the role of KTO is believed to be support rather than governing or service provision.

Attitude towards IP and its protection is not well articulated on average across the cases in this study. Usually the status stays at one extreme end of attaching no relevance or value to them, or to another of over-protecting them with some considerable exceptions.

This means somehow that business and industry are not priorities for most universities, which is partly rooted in the perceptions of innovation among KTO professional that is considerably different and in many cases distant from those understood within business and private sector. Corporate approach to IP management and knowledge transfer in cases is seen as a potential danger to the institute in losing their focus off their main goals (teaching and research).

Moreover, limitations of resources and infrastructure, which include public funds, regional development level, active industry in the area and consequently the geographical distance with the university, as well as networks etc, do not help the KTOs to find a more proactive role for themselves. Measurement of results and outputs partly imposed by the government, and partly as the legacy institutional practices put considerable load on the KTOs and press them out of their ways sometimes. It is evident that dynamics and diversity of activities and roles of HEIs and hence KTOs are not projected in the KTO and their corresponding measurement systems. In addition, in terms of the human resources, it is believed that professionalism and role of leadership is playing an essential role in the success of knowledge transfer in KTOs, by the same token, one of the barriers are counted is the difficulty in recruiting right professionals.

3. The spectrum of KTO management

The management of university knowledge transfer offices in the UK are undergoing a process of transition in line with the changing ecosystem and the development of university knowledge transfer strategy. In the course of this transition, the management level of KTOs varied considerably due to the various interests and strategies by stakeholders, the complexity of university knowledge transfer activities, and development level of management. Utilizing axial coding, this section was aimed to explore the pattern of the KTO management and mapping the present situation of KTOs' management in the UK.

The management of KTOs reflects KTOs' commitment to work as the governing body in the university knowledge transfer system to align interests from a variety of stakeholders, and coordinate the activities with stakeholders. Through constant comparison between each case, displayed in the 'mega-matrix', each of the management elements of KTO was explored. Herein the mega-matrix was managed and displayed by QSR Nvivo 8.0. The result of this part is specifically focused on determining the

spectrum of performance across the KTOs studied leading to a classified set of definitions and statements defining them that will be presented at the end of the analysis.

3.1. Strategy: from research supporting and funding maximization to dissemination maximisation

KTOs' strategy and policy are shaped by aligning the strategies and interests of key stakeholders, among which the university is viewed by most as the foremost stakeholder. As a result, most selected KTOs view themselves as institutional expression of universities' mission to provide public benefits by putting research to use. Nevertheless, the strategies of KTO varied substantially across the participant universities. In some instances, KTOs place the management emphasis on the traditional streams of university industry interactions, that is, education and research. In this sense, KTOs view themselves as promoting core academic values such as dissemination of knowledge through education, publication and expansion of research. The typical viewpoints by these cases are stated as 'supporting research was the main goal of the KTO with IP portfolio management described as a 'side effect' or 'peripheral". For example, one KTO has its director reporting to the research committee which determine the university's research strategy although it does not include knowledge transfer strategy. They even do not have a clear strategy for KTO itself, and regard KTO as part of research mission, which implies that the core strategy of KTO is merely to support the research. In another case, the KTO officer mentioned that although the funding is increasingly seen as the critical contribution of KTO for university, the revenue generated are considered as 'an auxiliary benefit' of KTOs' main missions of supporting the university research activities. This strategy reflected many universities' concern of losing the 'core' identity of university when they entered into the era of entrepreneurial university (Mowery & Sampat, 2006; O'Shea et al., 2007). Internal focus is also valued by many KTOs. A typical statement is '...the main mission [of KTO] is the exploitation of research where staff 'speak academic language' and work with academic staff to increase grant funding and income, plus more commercial support activities such as finance, legal, contracts, business orientated specialists'. Furthermore, in case of conflicts between knowledge transfer and education the knowledge transfer is always the one to be abnegated, as one KTO practitioner said: 'we should not be doing a research deal with company while another unit of KTO is arguing with this company

over course content for teaching students they might employ'. This mirrors the situation that KTOs are still positioning knowledge transfer activities as a subordinate function for promotion of university research.

Considering that the initial raison d'être of university KTO is to facilitate the commercialisation of university knowledge, KTOs are usually measured by their financial performance such as the HEBCI metrics which is widely accepted by policy makers. In this regard, the mission of KTO is to adequately support research funding applications and to provide expert guidance and to exploit IP. As one practitioner said, "KTOs have been driven by 'count' rather than making an impact, visibility, and regional influence". Also seen from the performance indicators by KTOs, the major mission is narrowly determined to grant seeking and maintaining. The commercialisation is therefore regarded as the core mission of KTOs. As one practitioner in KTO mentioned, 'we are very careful to define knowledge transfer within the remit as "commercialisation" rather than "softer" community engagement etc'. With this vision, knowledge transfer is viewed as the critical mission of university in the new R&D environment where companies, government, and other investors commit to financing and acquire knowledge from the university. Nevertheless, the focus of this type of strategy is placed on the finance income and grant seeking where the wider benefit for a broader range of stakeholders are not proactively considered. In some cases, the remit of KTO has been narrowed into licensing and spinout, hence the core of their work is narrowed and over simplified to revenues and numbers. This strategy narrows the KTO's perspective to barriers and prevents the informal or ongoing possible relations between faculty and industry by becoming too much patent solicitors. For example, one practitioner mentioned that 'the performance indicator is set by university strategy...All related to research income'. For IP they use the usual metrics of disclosures patents etc. 'Neither wanted to be committed to targets for spinouts or licenses... believing that IP should own the route most appropriate, not try and meet targets'.

In contrast to the above two types of strategies by some KTOs, some other KTOs have clear vision on their missions towards the knowledge transfer. In these cases, KTOs intend to take a pro-active role in connecting university and industry, and recognise the value of knowledge transfer to a wider spectrum of stakeholders. Internally these KTOs have strong intention in cultivating the academic entrepreneurship within universities.

Just as a manager of KTO stated that 'the main objective of the KTO is currently to raise and enhance the entrepreneurship within the university, ...and the main focus of KTO as creating strong link with industry through a range of conduits'. Externally, these KTOs are proactively building network with external stakeholders to cultivate 'trust' with them. And more importantly they view knowledge transfer from a broader perspective which considering the stakeholder's benefit, such as the community engagement and internationalisation are seen as significant mission by KTO. For example, in one case the KTO changed its focus from supporting research and consultancy to managing research and knowledge exchange which reflects a university wide exercise to look at a wider external perspective. This KTO decided to project a more accurate multi-dimensional image to the broad community. Furthermore, some KTOs have been actively working as the 'institutional entrepreneurs'(Jain & George, 2007) which was defined as actors 'actively mobilise resources to create new institutional logics or transform existing logics or frameworks'. These KTOs disseminate knowledge about the innovation and ensure that key stakeholders accept it as appropriate. To this point, these KTOs can be understood as the 'governing body' of the university knowledge transfer system, which build their strategy towards the emerging institutional landscapes. The strategies of these KTOs include developing norms of interaction between actors and influencing the perceptions of key stakeholders, and mobilising stakeholders to cooperate with each other and align their divergent interests. KTOs view the knowledge transfer as the means to exploit knowledge of universities in collaboration with any interested entity for generating wealth for all stakeholders and promoting innovation.

3.2. Process: from complex and sluggish to simple and efficient

The process management pertaining to KTO can be understood as two processes working together to deliver the outcomes. These two are the implementation process and the decision making process. The implementation process has been studied extensively by researchers (Agrawal, 2001; Debackere & Veugelers, 2005; Perkmann & Walsh, 2007), who usually include channels of university knowledge transfer such as licensing, contract research and spinout etc. D'Este and Patel(2007) also pointed that the unconventional knowledge transfer channels are also deemed critical to university industry interactions. With respect to these processes, generally participants have some common views. For example some believed 'university knowledge transfer is not a linear

process and interventions by stakeholders can distort processes. One emphasized: 'I feel that an intervention can use effort in accounting for its application rather than in getting the end result e.g. we needed reporting which used time that could have been dedicated to establishing a company.' Another said: 'The process of knowledge transfer is considered as a feedback loop process and the research base is intrinsic to commercial success, and then commercial success feeds back into the research base'. The KTOs' position in such process is also understood well. For example, in one case they stated that 'the process is circular - need to improve the performance and ethos of 'knowledge exchange' by the university which the KTO is now at the core of. Also the KTO is now actively looking to engage business in partnerships and in support of knowledge transfer activities. Collectively these two dimensions enhance the knowledge transfer process and the KTO underpins this.' These common views reflect the standardised 'stage-gate' processes are well recognised by practitioners and industry and simplify the process of communication and negotiation, such as one practitioner mentioned 'the [KTO] ought to have standard processes for processing activity and overall stage-gates etc for generic processes'. And others said 'the focus of activities in the office has evolved with the university strategy but has been relatively stable since the mid 1990s'. Additionally, the standardisation processes of knowledge transfer also can be found in most KTOs' guidance to business and faculty.

Along with the analysis on differences existing among the cases, it was noticed that the other facet of the process - the decision making processes of KTOs exhibit considerable disparity. In some cases, the decision making process by KTOs is very time consuming and complicated. As one practitioner said '...commercialisation decisions were not easy whereas research seemed to need 25 signatures', and in some other KTOs the decision making processes are fragmented and complicated. For example in one university, the KTO sits within the overarching research services section but reports to the deputy principal of research who has a strategic responsibility. There is however another deputy principal who has an input to the research portfolio albeit with a more 'operational focus'. Portfolios change with individuals. These two are the most in tune of those in recent years. There are different levels of senior academic managers and the office can report to any level according to the decisions on personal portfolios and is thus vulnerable to changes in personnel. Additionally there are four committees which impact on the work of the office. For example, decisions to spin-out go through several of those to the business ventures committee whereas decisions on collaborative research

awards are signed off in the KTO. In these cases, the decision making rights are misaligned and KTOs just serve as a unit to process information and coordinate routine activities. As a result, some KTOs claimed that their activities have 'weak responsiveness and speed...which may attribute to several factors but clashes existing in decision making are very serious'. In contrast to the above complex decision making process, some other KTOs have relatively simple decision making process and the decision making authorities and responsibilities are clear and aligned with the missions and functions of KTOs. A typical case is in a research based university, each faculty sets up a special knowledge transfer sub-dean post to integrate the university's strategy, information and resources for the purposes of simplifying the process of decision making. In general, there exists a gap between the decision making process and the implementation process, which can be attributed to some KTOs inheriting the complex and academic style of organisational structure from the traditional university based establishments.

3.3. Platform: structure from hierarchical to distributed and flexible

The structure is the most obvious and explicit building block of this KTO management framework under the heading of Platform. We obtained the information needed directly from the organisational charts and description by managers of KTO. Our samples of KTOs are mainly department type entities under an administrator within the university which typically have other significant responsibilities, such as research support, finance management etc. According to the KTOs visited, broadly the organisational structure of the KTO comprises of three functions: research management and support including research funds seeking and maintaining, marketing and dissemination i.e., marketing and networking, and commercialisation which covers business development, incubation and spin-outs.

Over the past decade, most KTOs we visited have restructured their organisation. In general, an evolution can be seen in the movement of the KTO from an original location as part of the research infrastructure to a relative independent entity and then to a part of a broader focus on innovation related activities. As one practitioner mentioned that '...the KTO is slowly moving from a very structured approach with layers of decision-making at the centre to one which embraces the academic units more but this will be a long and slow process'. Recently a consolidated approach seems to have been adopted across a large proportion of samples we visited. One stated that

'structure rethinking during mergers – a process of evolution, now sitting comfortably 'inside' the university while having external and internal remit' and another said 'since the new structure instigated in late 2006 was more fragmented, now we are looking to consolidate and devolve responsibilities through university back to academic staff including driving commercial activities from the ground up'. The consolidation strategy has been proved to be efficient considering the previous experiences. One said that '...the restructuring in 2006 resulted in streamlining and focus of strategy, and functions reviewed and consolidated to be proved as more efficient in decision making processes'. Additionally, in some cases, KTOs has attracted attention as part of an entrepreneurial mission for the university, and the KTOs are grouped along with other agents (venture capital, incubator, entrepreneurial training, and start-up assistance) as institutional entrepreneurs.

3.4. People: capability and culture are changing

There are two elements pertaining to the people issue of KTO management, capability and culture. In the past or even recently, businesses criticised KTO people for being too academic or too narrowly focused on patenting (Wright et al., 2007).Along with the evolution of university entrepreneurship, KTOs have developed a broad range of scientific, legal and business skills. KTOs are capable of being accepted as knowledgeable and serious negotiating partners by their industrial counterparts. Sharing a common scientific background with the faculty, KTOs offer professional service to the faculty and the university administration, representing the commercial and academic interest of the university in knowledge transfer. As one KTO practitioner said '...[our] expertise broadly encompasses knowledge transfer, commercialisation and IP; funding development; regional engagement, pre-award advice and support, sales support and business 'gateway', marketing communications, and developing and delivering enterprise initiatives and teaching to students'. In term of spinout support, the lack of skills is understood by many as a main problem. KTO practitioners also claim that KTOs point to lack of availability of good business managers, who can be employed in knowledge transfer and spin-out activities in their organisations. These units need business people to run spin-outs and have sufficient professionals around them'

With respect to the culture of the KTO management, we also noticed a spectrum of culture within different KTOs. One high ranked university which is claiming to be 'the entrepreneurial university' but seems, according to the interviewee, to have lost its edge

in the KTO. There is too much risk aversion in the organisation and even academic enterprise is being stifled by this culture. In contrast, some other KTOs have very strong ethos of working with industry in academic departments but objectives might be personal rather than corporate. Furthermore, in some cases I found the existing business style atmosphere. The KTO practitioners who participated in this study showed to be very open to new ideas and collaboration – if it increases income or makes them more effective. The model followed by this group is seen to be functioning perfectly well.

Table 14 the Taxonomy of KTOs' management style

Managerial elements	Proactive	Responsive	Reactive
Strategy	The strong third stream activities oriented and have clear vision on academic entrepreneurship development	The government and business funding oriented	The first two stream activities oriented strategy and knowledge transfer is peripheral to university
Process	Business style of decision making process covering a wide spectrum of knowledge transfer activities	Smooth decision making process focusing on several knowledge transfer activities	Complex and slow decision making process, not comply with the strategy
Platform	consolidated and distributed organizational structure covering all aspects of knowledge transfer activities	Centralized office comprise of different functions which are based on relationships	Very structural, functions are relatively isolated with each other, the collaboration is limited and causes the slow decision making process
People	Strong skills and capable of being accepted as knowledgeable and serious negotiating partners by their industrial counterparts	Capable of doing traditional business very well but lack of skills in specific areas such as spinout development	Rely on leadership instead of organizational capability

The data gathered during the study provided sufficient material to attempt a taxonomic projection of KTOs in terms of their performance from a managerial point of view. I developed a three level taxonomy of performance each associating with a role the university knowledge transfer could play in the innovation game. Reactive, responsive, and proactive are the defined levels which will be characterised with factors such as strategy, people, process and platform. **Table 13** presents the spectrum of the KTOs management with a descriptive suggestion of each state for the four areas studied. It is important to point out that imbalances also exist in individual KTO, that it to say, in individual KTO different management elements may locate in different categories of styles mentioned above. This incongruence also reflects the state of transition of KTO management and the complexity associated with the management of this specific organization.

4. Understanding features of university knowledge transfer

As discussed before, the entrepreneurial university is an emergent phenomenon that is a result of the working out of a previous 'inner logic' of university development (Etzkowitz, 2003a). In this milieu, the conventional concepts of academic research, dissemination, and even education are all being redefined, resulting in changes, sometimes dramatic but often more incremental, in the organisation and behaviour of the academics. From a management perspective, the entrepreneurial universities have exhibited some salient features in their knowledge transfer mechanisms. In this respect, the entrepreneurial university knowledge transfer could also be understood as an 'open' system and mechanism which embraces a wider spectrum of stakeholders and business models. On the basis of the multiple case study data of KTO management, this section describes the findings with regard to the salient features of university knowledge transfer system in response to new innovation models.

KTOs' management remain as the unit of analysis, however the boundary of the issues looked at through the study is broadened to cover the entire university knowledge transfer system. The 'selective coding principle' of Grounded Theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990) is adopted in the data analysis for the purpose of developing overarching themes throughout the datasets. Different from the previous section, where the comparison of cases was the main focus, in this section the emphasis is placed on the 'variables' which are identified and labelled in the course of open coding and axial coding, such as the performance indicators, mechanism of knowledge

flow and so on. In the first step in this data analysis process, notes from each interview, made both during and after the interview were reviewed and highlights or new concepts were labelled. Secondly, the transcript from each interview was combined with the observation notes and information from KTO web sites were pooled in database using which the information was reviewed and coded. As the process continued, each new interview was compared to the previous ones for confirming or disconfirming evidence while those earlier interviews were compared to the latter in the light of new concepts identified in later interviews (Strauss & Corbin, 1990).

4.1. Feature 1: equal importance of external knowledge and internal knowledge

The university knowledge transfer is based on the logic that organisations could and should tap into external sources of technology to achieve results beyond their own internal capabilities (Chesbrough, 2003a; Fabrizo, 2006). The diminishing of corporate culture and development of knowledge economy has brought universities to the central stage of innovation considering their deep expertise, publicly funded facilities for research, human resources, and a policy support. University knowledge however spreads across a wide range of disciplines and hence concentration in individual institutes could be limited due to the high level of specialisation. This means that R&D in university can be complemented by external sources same as the industry when it comes to exploiting result for industrial use and application. Studies have however shown cultural inhibition and barriers to engagement KTOs (Etzkowitz, 2003a) have reported difficulties in encouraging faculty to disclose their research let alone proactive approach to networking and accessing external sources of knowledge (Chapple et al., 2005; Siegel et al., 2003b). This issue impinges on many aspects of universities' knowledge transfer activities. On one hand, with respect to academics: while they inherently inclined to collaborate externally, the potential tendency towards the 'not invented here' syndrome (Chesbrough, 2006b) can hinder the connectivity expected. Meanwhile, the motivation for the faculty to work with business often rooted in the knowledge exchange, that is to say, acquiring knowledge from business. Therefore the KTO strategy and practice could be redirected to assist in facilitating connectivity with R&D activities, say, within other departments in university or in other universities, relevant to achieving viable commercial exploitation. As one practitioner stated '...we bring in practical help from outside or external organisation with desire and vision, not only inventions, linking with

research to help us with marketing, ideas, and creative academics where the hope is to get serendipity results'. On the other hand, in relation to the practice of knowledge transfer, say, exploitation of knowledge and related capabilities, universities' knowledge transfer strategies should be supportive and capable to seek a wider array of expertise from external resources such as, consultants, intermediaries, venture capitals and other knowledge transfer practitioners, and not limit itself to structured public funds such as "third mission funding", which is a totally different approach for universities. In another case, the university knowledge transfer office resorted to commercial technology intermediaries to commercialise the university knowledge. They built partnership and have routine meetings every month. The practitioner stated 'they [intermediary] are playing important role in our knowledge transfer... we used these expert intermediaries between firms and the University to spot and develop opportunities for co-operation and profitable innovations... [Their role] is not only in marketing technology...more importantly have they offered a mechanism for us to work with the demand. ' Furthermore, this will involve a strategic approach in developing absorptive capacity through engaging in and stimulating networks and the capability to continuously scan for and adopt technologies that might provide a competitive advantage for the successful exploitation of internally generated technologies. Likewise adopting externally developed and tested business models might be as important to successful knowledge transfer.

4.2. Feature 2: valuing the role of business model

Chesbrough suggest that the main role of a business model is to create a heuristic and simplified cognitive map from the technical domain of inputs to the social domain of outputs (Chesbrough & Rosenbloom, 2002). A business model however can be a "double-edged sword"(Osterwalder, Pigneur, & Tucci, 2005) as it involves a process of selection in which alternatives should be filtered for the best outcome and hence there exists a danger of missing better business models due to conflicts with the organisation's existing model. Universities' position in the game of innovation seems to lack a serious conception of the importance and definition of business model. The literature has remained relatively quiet on this subject while it has been strongly emphasised by the theorists in industrial innovation(Chesbrough, 2006a; Dodgson et al., 2006). This could have been due to the sensitive nature of the concept within a suspicious environment, as well as the newness of the idea to the academic institutions.

Nevertheless, university KTO practitioner are gradually viewing the university knowledge from business model perspective. For example, a practitioner mentioned 'now there is a shift towards pursuing more strategic partnerships and collaborations so systematising the business model creating a leaner meaner model based on core function of the university and bringing in strategic partners to that business model as required.' And another participant stated that 'For wider knowledge exchange there are no explicit business models, but this is changing now the KTO is consolidating and its activity range is increasing. The knowledge transfer business models in our university have grown organically, but now reached critical mass to establish a business model. The business model is now growing importance'. However the ability to use various business models for different sectors, fields and opportunities can be a critical issue for university knowledge transfer. In the same time it is possible to suggest that the level of flexibility in terms of ranges of business models which such organisations can adopt is higher than that it is accustomed in industry. For instance a range of business models relevant to what universities do could include, and of course not limited to: spin out, start ups, licensing, research and consultancy, publications, and other regional engagement, each which may entail a further broad range of business models relevant for creating maximum value within the network of involved stakeholders. The role of KTO in here is critical to identify the right approach and definition adaptable to the culture of the organisation and to promote and apply it. For instance in one case, the KTO has set up clear prior business model to maximise the efficiency of the dissemination. They said '[we are] not competing with Russell group universities on blue sky research or commercialisation, and so [our] strength is building on the capacity of the 56 research groups for contract research. This is our unique selling proposition. There is a plan to consolidate the contract research programme and focus on the leading 6-8 research groups for principal income generation in the first instance with key industrial 'partners'... [to] do this requires the assimilation of academic and industrial values and ideologies which again relates to promoting academic awareness and seeing potential opportunities initially with the help of the business development managers'.

4.3.Feature 3: proactive management of IP

This mainly relates to the issue of significant 'wastage' of IP in universities which is often patented but not exploited and therefore new routes to 'spin-out' are desperately needed. The increasing drive to commercialise the university knowledge and protecting

the resulting IPs has been extensively witnessed and reported in the literature. In the same time limitations related with the appropriation regimes for rent distribution(Chesbrough, 2003b; Teece, 1986) leading to overprotection of the rights within universities have led to a considerable quantity of shelved IPs which could have potential economic value. As knowledge transfer practitioners noticed 'as everyone they go for low hanging fruit and ignore unripe or higher up stuff. The important thing was to react if offered an opportunity by the academic... implication was that it did not matter what the outcome was as long as the KTO reacted and so build a relationship which might produce easier results in the longer term'. Likewise, KTOs are becoming more sensible in dealing with their IP portfolio, for example, '...schools have become more aware of IP assets – the university has become better at recognising what is 'background or residual IP' that it must retain in order to do contract research and consultancy. University and KTO are becoming smarter in IP management'. Nevertheless, it is certainly debatable that policy and practice in university knowledge systems is proactive and nuanced in term of managing the IP portfolio. Issues such as lack of consideration of the business model in the process of IP protection, and a typical adoption of linear stage-gate process can be mentioned to exist in universities. For this purpose it is critical for universities to be aware of this fact and also set their IP management mechanism focused on a 'business model'.

4.4. Feature 4: diversified intermediaries for knowledge transfer

The role of intermediaries in innovation has already been well studied by researchers (Chesbrough, 2006a; Howells, 2006; Lamoreaux & L.Sokoloff, 2002; Linder, Jarvenpaa, & Davenport, 2003; Shohet & Prevezer, 1996), and the concept has long been practised in universities through establishment of knowledge transfer offices(Macho-Stadler et al., 2007). However the role of intermediaries has changed in the wider environment of innovation and they are now playing a more direct role (Chesbrough, 2003c). Stakeholders in the emerged intermediate markets can transact in ways which used to be as internal processes. Recognising this fact and inclusion of any possible channel which fits the universities knowledge transfer is a necessary move for further development of university mission for knowledge transfer. Literature has examined this issue under the structure subject of KTOs and have proposed a combination of centralised and decentralised models, matrix organisation(Debackere & Veugelers, 2005; Feller et al., 2002b), as well as parallel use of various intermediaries. However the main tendency in

academic institutes has been centrally controlled offices solely governing the knowledge transfer in the process when other agents or agencies may be involved. For instance, in term of international development, the intermediaries are particularly useful, as one practitioner said '... for instance, the Singapore licensing agent by which the university has a major development in Singapore is part of global strategy for the university. We have the strong willingness to use external support in marketing'. Another stated '...we are the formal channel for commercial activities with ownership of all IP derived from the university – however we have the option to introduce external intermediaries to strengthen the knowledge transfer process... we have excellent links with regional legal specialists and venture capitalists, and national contacts through the fund in which we partner with other universities...'

Another more recently highlighted dimension for the university role in the knowledge based economy is its potential to contribute to the regional and global development(NESTA, 2007). Etzkowitz and Klofsten (2003)suggested the idea of "innovating region" in which university usually plays a pivotal role. In this multi linear model firm-formation strategy becomes tied to a research base, which is different from the traditional linear model of knowledge transfer to industry through publication or mobility of graduates but rather an 'assisted linear model'(Etzkowitz, 2006) comprising a variety of interlocking organisational mechanism such as research centres, knowledge transfer offices and incubators that move research with long-term commercial potential into use. Establishing and recognising channels of knowledge transfer for these purposes will open new fronts of university-community engagement and channels. This in particular will positively impact upon universities with lower level of research intensity to capitalise on the knowledge produced in their systems for benefiting the society and also join the innovation system in a different business model. As a practitioner said '... [we] have not looked at any parallel models but do use market research and business planning support provided by local intermediaries and RDA'

4.5. Feature 5: reconsidering performance measures for knowledge transfer

Conventional metrics frameworks adopted by and sometimes imposed to universities for measuring knowledge transfer and their social and economic impacts will not support the approach to achieving new capabilities, and maximum benefit for all stakeholders. Feller et al(2002b) argued that using right measure is critical and that

intentionally or not, benchmarking may compress institutional strategies into fewer options, thereby reducing its flexibility to capitalise on its distinctive niches or singular opportunities. They suggest a careful assessment of underlying strategies is needed in setting the benchmarking measures. From university knowledge transfer perspective, the practitioners noticed the existing problem of limited metrics. As a senior practitioner mentioned '...the role of the KTO is to understand what is needed by all parties and facilitate delivery, but all the expected rents were financial. Although government wanted jobs, meeting of policy objectives through application of technology, etc.' More importantly, in the case study I also discerned a wide consensus that the value of knowledge should be measured against the business model and the generated benefit to stakeholders. And that in order to apply a comprehensive view a combination of tangible and intangible measures to include social, business, and academic values should be taken into account by KTOs. Measures are also to extend to include all stakeholders in the knowledge transfer value chain. For instance, one KTO manager said'...apart from the HEBCI based metrics, we are looking at some qualitative and non-financial issues which are more valuable to the university and other stakeholders'. And another practitioner's thinking is more explicit that 'they [government agencies] are not positively contributing to that debate and to thinking about that landscape, they're actually thinking that economic impact means metrics; and economic impact measuring our institutional individual performance. I think that is destructive because all the debate around metrics are trying to say you've got metrics to take the temperature of something but then you're deciding on the treatment based on the temperature that you take, whereas you should just take the temperature as an observational mechanism to inform whether things are going well or badly and then to see if there's something that can be done to improve them rather than using metrics as a mechanism to judge performance and then to hand out cash.'

These characteristics form the basis for what can be called an 'open' knowledge transfer system for university due to its consistency with the Chesbrough's (2006b) summarization of the features of the open innovation in comparison to the legacy innovation models. Governing the university knowledge exchange within the emerging new models of knowledge exchange and innovation requires application of new and different principles, set on defining a proactive role for the governance system to serve the expectations of stakeholders of this business.

5. Concluding remarks

The emergence of entrepreneurial university, the transformation of university economics, and some fundamental shifts in global economy and its underlying theories have led to a new strategic role for the university in the innovation game and new knowledge based economy. Researchers have found universities as legitimate and effective agents for bridging the gap between the two models of state based and corporation based knowledge production and dissemination. An institutional interpretation of knowledge transfer emanated from this need should be properly set forward and applied in undertaking the university's new roles.

The paradigm of open innovation (Chesbrough, 2003b) has considered universities as a major source of knowledge and a potential partner in the new models for enhancing and facilitating innovation for success in business. This view however did not seem to have yet recognised university as an entity which could play the same game and hence become an integral part of the national and global innovation systems. This theoretical oversight might have been caused mainly due to the traditional nature and definition of universities and their mission, expectations from governments partly reflected in policies and legislations, as well as the internal culture of such institutes among academics. Another fact contributing to this need for strategic repositioning the university in the innovation game is the new socio-economic role of regional and global development for university which brings in a wider range of higher education institutes as players into the game. A successful performance in governing the university knowledge transfer to the business and community could be associated with three main elements of setting up an appropriate and well balanced incentive system for all involved stakeholders, a system of communication and signalling and managing the process, and a model to improve the capacity and interest of users (business and community) to receive the university knowledge. I have presented an interpretation model for evaluation and positioning of the KTO, which suggests a three level taxonomy of KTO management style. While the levels help to find the position of the KTO, set a journey route and place goals for achievements it should be said that performing at reactive and responsive levels could well suit certain institutes and circumstances.

Moreover, acting entrepreneurial means valuing the external knowledge same as the internal and setting necessary means of interconnecting the institution with its environmental counterparts. Also employing a business model based approach to

knowledge transfer, sensitivity to IP wastage and proactive approach to their exploitation, recognising and synchronised mobilisation of all viable channels and applying appropriate and sound methods and modes of evaluation and measurement are other factors. A more suitable term to express this model might be 'open university knowledge transfer', a model which brings KTO and knowledge transfer management principles and practices together.

The picture of KTOs studied shows that KTOs in the UK is in a transition state towards a more entrepreneurial and open system of knowledge management and exploitation. The transition state has imposed a range of challenges on the universities the most critical of which is the increased complexity in the process and functions to which the traditional organisational structure of the university is not used to. A range of good practices in terms of organisational formation, process, networking and communication, outsourcing of services, as well as some exemplary strategic settings for alignment of value chain, open regimes of IP exploitation and interconnected management are identified that partially fit the open university knowledge transfer. However the criticality still remains with the absence of a fit between the strategic positioning, which has received strong perceptive support from the studied cases, and the structural and organisational formation and practice. Adding to this is the unfilled gap between the university and the community of recipients that is missing from the list of priority stakeholders of KTOs. This may partly be addressed by reforming business models for university-industry relationship management and reshaping the organisational structure accordingly.

6. Summary

By adopting the Grounded Theory methodology this chapter presented the process and results of the study conducted in 23 universities across the UK. In this chapter, the research identified a spectrum of university KTOs management style, namely *proactive, responsive and reactive*, which revealed the imbalance and complexity of current KTOs management in the context that universities are in a state of transition into entrepreneurial universities. In addition, the features of the university KTO management were also revealed to reflect the development of the university knowledge transfer. These features correspond with the principles of open innovation paradigm(Chesbrough, 2006b), which suggests that universities can consider the introduction of open innovation principles in the domain of knowledge transfer.

CHAPTER VI. UNDERSTANDING THE PERCEPTIONS OF UNIVERSITY KNOWLEDGE TRANSFER PRACTITIONERS: A Q METHODOLOGY STUDY

1. Introduction

The goal of this study is to provide further insight in to the diversity and complexity of the cognition pertaining to leading practitioners concerning the 'open' KTOs management proposed in previous empirical study. To achieve this goal, this study utilizes Q methodology to explore and identify the pattern of perceptions of university knowledge transfer practitioners associated with the management of KTOs. Moreover, this study also intends to examine if, and how, emergent perspectives from the study are related to features of open KTOs management identified in **Chapter 4**. This objective was achieved via theoretically comparing the emergent patterns of perceptions to the features of open KTOs management identified in previous chapter.

This chapter will first briefly describe the theoretical underpinnings of study of perceptions of senior knowledge transfer practitioners, mainly from the managerial cognition and upper-echelon's perspective in the domain of strategy management. Then the procedure of implementing Q methodology for the purpose of studying participants' subjective perceptions will be briefly explained in accordance with the principles and elements of Q methodology presented in **Chapter 2**. Following this, the implementation of the Q study including the development of Q statements and relevant underpinnings will be presented. This will be done by presenting each step in the general building of a Q sort and explaining how this took place for the current study. After that, the data collection, including a pilot study and formal Q sorting, will be described, which is followed by data analysis of the study. At the end of this chapter, patterns of practitioners' perceptions are analyzed and interpreted, which are also compared with the features of 'open knowledge transfer' proposed in **Chapter 4**, and discussed in length.

2. The theoretical underpinnings

This study focuses on the perception of leading practitioners concerning the KTOs management issues. Leading practitioners in KTOs not only serve as the cadre in providing professional services for stakeholders but also play critical roles in steering the strategic development of KTOs (Siegel et al., 2003b; Wright et al., 2007). By this token, the perceptions of these leading practitioners have significant influence over the strategic decision-making of university knowledge transfer activities. Theoretically two streams of strategy management theory underpin the understanding of leading

practitioners' roles in strategic decision making. From a managerial cognition perspective, the information-processing capabilities of senior managers exert significant influence over a variety of organizational phenomena, including strategic decisions (Barr et al., 1992; Stubbart, 1989). Similarly, the upper echelons perspective argues the organization is a reflection of its top managers: 'organizational outcomes – both strategies and effectiveness – are viewed as reflections of the values and cognitive bases of powerful actors in the organization' (Hambrick & Mason, 1984). These assertions are rooted in the observation that senior managers interpret issues relevant to strategic decision-making and possess the power necessary for implementing choices derived from those interpretations (Hambrick & Mason, 1984). In addition, these propositions are predicated on the recognition that the concept of strategy consists not merely of a chosen position, but of an integrated way of interpreting and 'enacting' the business environment (Daft & Weick, 1984). As such, these two streams of theory are therefore regarded as underpinnings to the significance of the leading practitioners' perception to KTO management.

3. Purposes of research

Universities in the UK have been shifting from conventional teaching and research focussed to entrepreneurial entities (Clark, 1998; Etzkowitz & Webster, 1998; Etzkowitz et al., 2000) and KTOs are also in the state of transition to embracing a broad range of missions. In this context, previous empirical study has revealed the 'open' features associated with the university knowledge transfer and the management of KTOs, and also found that the perceptions of leading practitioners regarding KTOs management have characteristics of complexity and diversity in place. Considering that the strategic management theories emphasized the significance of leading practitioners' perceptions in steering knowledge transfer strategy and decision making, one purpose of this study is to investigate patterns of practitioners' understanding and perception regarding the principles of 'open' university knowledge transfer and university KTO management, which have been revealed in previous empirical study. This also corresponds to the second primary research question stated in **Chapter 1**.

Moreover, as mentioned in **Chapter 3** much of the research published in the domain of research on university knowledge transfer have a long tradition of employing case studies and econometric analysis. However these methodologies have certain weakness and difficulties in offering appropriate means of investigating the subjective issues, in particular cognitive issues such as viewpoints, values and positions (Brown, 1980; McKeown & Thomas, 1988; Steelman & Maguire, 1999). In addition, endeavours of researching subjective conceptions or individuals' personal views are difficult and challenging. According to Brown (1980), subjectivity is 'sometimes thought to be

impossible to study systematically or with any degree of precision'. Oftentimes researchers prefer to deal with 'facts' or empirically established and therefore avoid addressing subjective issues such as value, preference and perception (Kerlinger & Lee, 2000; Steelman & Maguire, 1999). In this situation, Q methodology has emerged to fill this void as aforementioned in **Chapter 3**. In general it can provide shaper and more systematic insight into the preference and perception hold by people, in other words, Q methodology can provide a 'systematic and rigorous means for examining human subjectivity' (McKeown & Thomas, 1988). However the extant research remains void in utilizing Q in the area of university knowledge transfer. Therefore, this study also intends to introduce Q methodology for a better understanding of participants' concerns about the university knowledge transfer and the management of KTOs.

In short, the purpose of this research therefore has two facets including (1) to map patterns of participants' perceptions and provide sharper insight into participant preferred management directions, and 2) to illustrate the utilization of Q methodology in the study of cognitive aspects of university knowledge transfer.

4. Implementation of Q methodology

In **Chapter3,** the background, key elements, procedures and quality evaluation of Q methodology have been systematically introduced. This chapter therefore will focus on the implementation of Q methodology in this specific study.

4.1. The outline

In Q methodology, through the use of qualitative and quantitative procedures, a meaningful understanding of perceptions and attitudes of participants can be properly formed. For the purpose of effectively combining the qualitative and quantitative study, generally the Q methodology based research includes three sequential stages: 1) developing a set of statements to be sorted, 2) arranging participants to sort the statements along a continuum of preferences, and 3) data are quantitatively analyzed and qualitatively interpreted. In the first stage, a concourse of statements was developed based on literature review and interviews conducted in previous multiple case study. These statements enable 'the respondent to model his or her viewpoints on a matter of subjective experience through the operational medium of a Q sort'(McKeown & Thomas, 1988). In this study, the 'structural' method of designing statements was utilized. In this way, the design process is simplified and meanwhile avoided the difficulty of reaching saturation point, which usually happens in 'unstructured' way of designing Q-sample (McKeown & Thomas, 1988). Following the first design, the draft

Q-set was further refined as a result of a pilot study and follow-up interviews with pilot study participants.

After the pilot study, the main study began – survey packages were sent to selected participants who were asked to rank-order statements into a continuum of preferences, also known as Q-sort. The Q sort is regarded as the most critical and most common form of Q methodology. This firstly involves providing participants with specific instructions about how to rank statements into predetermined categories (see **Appendix 5** and **Appendix 10**). Following this, participants were requested to examine the statements (known as Q-sample) and were instructed to place them into three categories. In this study, these categories are defined as 'agree, disagree and neutral'. Working from these categories, participants place these statements on a continuum (see **Appendix 10**) by following specific instructions provided so that participants alternate between focusing on high and low ends of the continuum while working towards the middle. Each level of the continuum was predetermined to include a specific number of statements. In this study, the continuum is set as '-4, -3, -2, -1, 0, +1, +2, +3, +4'. In the end, the Q sort resulted in a continuum in the form of 'disagree to agree'. This continuum was predetermined to reflect a normal distribution with a greater number of statements towards middle placement and fewer statements on the extremes. The reason for this is that as a result of the symmetrical forced distribution, rank ordered sorts from each subject have the same mean value and standard deviation thereby fulfilling the statistical requirements for homogeneity of variance needed for the application of correlation and factor analysis. In this way, the measurement of subjectivity can be made objective and structured, meanwhile enables researchers detect connections that might otherwise have been missed (Brown, 1980). Additionally this technique urges participants to consider items more systematically than they might otherwise, and is based on the idea that generally people hold strong opinions about relatively few issues compared to the number they do not have strong opinions about. In addition, according to Brown(1980), the scale of the continuum does not influence the result of the analysis significantly. However, as this study involves 48 statements, the scale of nine (say, from -4 to +4) is determined to reduce the over-high or -low kurtosis.

The last stage consists of data analysis and interpretation. The collected Q-sorts data are then correlated and factor-analyzed resulting in factors that represent cluster of perspectives. All these statistical calculations were mainly based on the utilization of PQMethod. Each participant's sort results in 'factor loadings' associated with each factor. Based on factor loadings, factors were determined and interpreted. As McKeown and Thomas(1988) summarized that the analysis process is following the standard 'sequential application of three sets of statistical procedures: correlations, factor analysis, and the

computation of factor scores'. Next, the interpretation continued until all factors with three or more definers were explained for highest- and lowest-ranking, distinguishing statements, as well as comparisons and contrasts to other factors.

4.2. Developing statements (Q-sample)

In this study, the development of Q-sample has two major sources: the theoretical development and a previous case study conducted by interviewing the leading knowledge transfer practitioners. The theoretical development of Q statements takes into account the 'open' vs. 'closed' style of management suggested in the previous case study and KTO management elements which are also taken from **Chapter 4**. In addition, the statement development also considered the views of practitioners, which was taken from the previous case study. To construct a balanced statement, these two issues (say, open knowledge transfer and managerial elements) led to a combination including 8 (2×4) categories. In order to capture as many different ideas as possible from each combined category, while keeping the total number of Q statements manageable to the Q sorters, each combined category was replicated 6 times for a Q sample size of 48. After the Q sample size was determined, all statements in the concourse were categorized into these combined categories. Within each category, statements with similar ideas or meaning were grouped together. Grouped statements were further examined based on their representativeness to the group and category based on subjective judgment. Statements considered less representative were eliminated or reworded, and this process was repeated until there were six statements remaining within each combined category. The remaining forty Q statements from the above process were selected from the concourse to make up a Q sample. Each selected statement was numbered and printed on a small card to be used in the Q sorting process.

In the statements, the 'open' refers to the 'open knowledge transfer' management features proposed in previous chapter, including new performance metrics, valuing of internal and external knowledge, proactive IP management, recognizing the importance of business model, and active connection with other intermediaries. In terms of management elements, this study covers a wide range of issues which come from the 'open coding stage' of previous study. Elements such as roles and positions of KTOs, leadership and culture, funding, structure and communication, performance measurement, IP management, stakeholder relationship, networking as well as knowledge transfer channels are included. **Table 6** displays the combination of 'perception on openness', and 'managerial elements'. The rest of this section will explain the meaning of each category and how statements were placed in each category.

Table 15 Development of statements

Issues	Levels	No.
perception on openness	*(a)open (b)closed*	2
management elements	*(c)strategy (d)process (e)platform (f)people*	4

- **The 'open' strategy management**

In terms of KTO management, the strategy refers to identification of its position in knowledge transfer system and its vision to long term development of organization (Feller et al., 2002b). Herein the interpretation of KTO strategy is almost identical to the strategy defined in **Chapter 4**. The statements in this category are connected to the combination of open principle with the strategy of KTO. In this category, the focus of statements regarding KTO's strategy is placed towards the open principles such as the stakeholder oriented, equal treatment of internal and external knowledge flow, as well as be flexible to new performance metrics. Q statements selected to reflect this thinking are illustrated as follows:

1. It is essential for KTO to set up a vision that values inflow and outflow knowledge equally

2. KTO's strategic policies should support the connectivity of university R&D activities with university's internal and external entities

9. KTO's operations strategy should be centred on identifying and valuing stakeholders' requirements and contribution

10. Ensuring, supporting and managing stakeholders' engagement in university knowledge transfer activities is a core mission of KTO

17. The performance indicator of KTO should represent a balance between different stakeholders' expectations and objectives in knowledge transfer

18. KTO's strategy should be flexible in introducing new performance metrics in knowledge transfer in response to its business environment

- **The open process management**

The 'open' process management refers to the process management of KTOs emphasizing on the enhancement of connections and interactions among knowledge transfer stakeholders, and meanwhile be flexible and adaptable to new business models. Importantly, seen from this angle, KTO's decision making process should be smooth

and efficient. The following statements are developed within this category:

7. KTO's support models for managing IP should be more flexible and proactive instead of being just protective

8. KTO's strategies in managing knowledge transfer agreements/contracts should consider expectations from researchers, university, and industry's innovation

15. University's knowledge transfer business models should be able to balance different stakeholders' requirements and expectations

16. KTO should introduce new business models to incentivise, encourage and facilitate academics and businesses' activities in knowledge transfer

23. KTO's major mission is to identify and mediate the conflicts existing within various channels of knowledge transfer

24. Measures and methods for auditing the efficiency of knowledge transfer need to take into account the difference between applied business models

- **The open people management**

The open approach to the people management of KTO highlights the importance of empowerment, distributed structure and distributed leadership pertaining to KTOs in facilitating university knowledge transfer activities. Moreover the new incentive mechanisms, capabilities and skills are also considered in developing statements. The following Q statements were selected to represent these ideas:

5. KTO should empower, encourage and enable KTO officials to enhance the interconnectivity between university, industry and other stakeholders

6. KTO's organizational leadership and culture are critical in supporting the setup of knowledge transfer strategy in adoption of open innovation paradigm

13. Besides pay, many other non-economic factors motivate KTO individuals in contributing to the university knowledge transfer

14. Distributed leadership and staff empowerment are critical to KTO's role of coordinating stakeholders' knowledge transfer processes

21. The knowledge transfer practitioners' capabilities in mediation and resolving conflicts are essential to successful governance of knowledge transfer activities

22. To monitor and assess the creativity and business acumen of academics is critical for the KTO

- **The open platform management**

As mentioned in **Chapter 4,** the platform in this thesis mainly focuses on issues like

resources management, and information system. In terms of 'open' platform, these issues are accordingly focused on two aspects: 1) facilitating networking, information sharing between stakeholders, and 2) effectively combine internal and external resources to support knowledge transfer. The following statements reflect these thoughts:

3. *KTO should actively seek external resources and new business models to exploit internally generated IPR*

4. *KTO should focus on establishing and maintaining effective networks with internal and external stakeholders*

11. *Free flow and transparency of information across organisational boundaries and different functions is an essential characteristic of knowledge transfer*

12. *KTO should support the models of managing IP in a manner of more openly and actively instead of just be protective.*

19. *KTO's strategic intention and efficiency in building and maintaining networks has significant impact on the effectiveness of knowledge transfer*

20. *Continuous updating KTO staff with new and important information about KTO's competitive environment can improve the efficiency of KTO management greatly*

- **Statements of 'closed' strategy**

As oppose to the 'open' strategy, in this category KTO's strategy and missions adhere to the legacy missions of university. Accordingly the performance measurement metrics were based on the conventional style. In this category, the strategies are internally focused. In other words, the academics and university administration are the pivot of KTOs knowledge transfer strategy. The following Q statements reflect these views:

25. *Protection and retention of the intellectual property are essential elements of KTO mission*

26. *KTO's strategy and activities should remain stable by incorporating only a few established business models*

30. *KTO cannot make all stakeholders happy and therefore the mobilisation of stakeholders is neither practical nor essential*

31. *The internally focused strategy will make the KTO work more efficiently and effectively for getting better results*

32. *Mobilizing and motivating academic researchers to engage in knowledge transfer is more important than working on external networks*

41. *Standard measurement system introduced by government for university knowledge transfer is sufficient for KTO management*

- **Statements of 'closed' process management**

Some views advocate the process management of KTO should be internally focused. Additionally business models are not, according to this view, essential to the success of knowledge transfer. Hence the conventional channels of knowledge transfer have precedence over the emerging channels, in other words, attitude towards business models are not flexible. The following statements mirror these views:

33. The focus of KTO operations is mainly to deal with and handle university administration and academic researchers' activities and interests

34. Business model is important but we already have one and it is not a big issue or very essential in knowledge transfer process

39. A few standard business models can fit with most knowledge transfer activities in universities

40. The channels and business models of university knowledge transfer are relatively fixed and therefore flexibility to business model is not a priority for KTO

47. The performance indicators regarding the inbound knowledge flow should be of less importance in the overall performance measurement

48. The economic indicators of exploiting university generated IP could represent the entire performance level of knowledge transfer

- **Statements of 'closed' people management**

The purposes of this 'closed' people management are not to facilitate the interconnectivity between stakeholders; therefore the relevant managerial issues such as empowerment, distributed leadership and structure, as well as the incentive system are not of interests to this style of management. The following statements reflect this thought:

29. KTO management should take the university, its administration and academic researchers as priority stakeholders

37. The organizational empowerment and distributed leadership should be constrained to achieve the purpose of protecting university's IPR

38. The primary role of KTO's knowledge transfer staff is to audit, monitor and control the knowledge transfer activities

45. In the KTO performance measurement the interconnectivity activities are and should be of less significant importance than internal resource management

46. The senior staff's capability to control the resources is more important than capability for communication and connectivity

42. The university senior management is the core authority to set up and monitor the strategy of KTO

- **Statements of 'closed' platform management**

The closed platform management connotes the information sharing infrastructure and financial resources are aimed to support internal focused activities, involving mainly the internal communication and academic research support. From this angle, the management of knowledge transfer platform centred in the conventional financial targets. The following statements are in this category.

27. The focus of organizational structure and related information sharing mechanism should be to improve the level of internal communication

28. When developing and managing the information system KTO should focus on integrating functions in the university and KTO

35. The KTO activities depend highly on the availability of internal resources

36. The information system is (and should be) mainly supporting the internal focused activities of KTO

43. Amount of raised funds should be the foremost criterion for measuring the performance of KTO

44. The return on investment is a critical factor to measure the efficiency of KTO

Generally, these 48 statements cover a broad range of issues associated with KTO management as well as the university knowledge transfer. These issues include the position and missions of KTO, performance measurement, relationships, IP management, channels and business models of knowledge transfer, as well as leadership and capabilities. The purposive coverage of this wider range of issues offers a comprehensive picture of the perceptions of practitioners.

4.3. Pilot study

A pilot study was first conducted to refine the Q-sample and to examine comprehension of the Q-sort instruction. What's more, the pilot study was utilized to (1) examine whether the wording of each statement is clear and convey the exact idea the researcher wants to convey; (2) identify flows of instructions of administering Q sorting; (3) get the researcher more familiar with the process of instructing Q sorters and conducting interviews after each sorting process; and (4) assess the participant validity and examine the time required to complete the Q-sort.

The pilot study involved two participants who are both heads of university based KTOs and had experience in both conducting knowledge transfer activities and managing KTOs. In the pilot study, a package for data collection was sent to each participant,

which contained 1) a draft of an introduction to the research topic, 2) a set of Q-sort instructions, 3) 48 statements cards with numbers at the bottom, 4) a scoring grid sheet for recording the results and 5) a questionnaire for obtaining demographic and personal information of participants. First, participants were informed that this is a pilot study and the data would not be used. Second the introduction to research and instructions were read to them. Importantly, the participants were explicitly informed that the key condition of instruction is ranking order statements corresponding to 'your own point of view' concerning research based information. Then participants were asked to start the Q sorting process and were observed during the process.

The participants took approximately 40 minutes each to read through the instruction and complete the Q sort as well as fill the demographic questionnaire. After completion, participants were invited to take a short interview, in which they were asked to assess the relevance of statements, evaluate the clarity of instructions, as well as provide suggestions for improving statements and instructions. The pilot study resulted in an enhanced study package, in which less meaningful and less relevant statements were reworded, instructions were optimized to eliminate difficulties for reading and reduce the time used for completing the Q-sort.

4.4. Sampling and data collection

The research utilized the postal survey as the primary means of data collection. The Q methodology's general principle of selecting participants had been taken into account. As McKeown and Thomas(1988) argued the purpose of Q methodology is to 'study intensively the self-referent perspective of particular individuals in order to understand...'. Hence specific sampling principles and techniques used in traditional survey research are not necessarily relevant to participants sampling in Q-methodology given the contrasting research orientation and purpose (Valenta & Wigger, 1997). For the same reason, Q methodology does not require a large number of participants in order to generate a diversity of accounts, rather is actually biased towards small participant samples and even a single sample. Thus it is understood that the subjective experience of even a single sample can provide meaningful understanding(Brown, 1980).

In this study, the sampling is purposive and takes into consideration theoretical relevance. Criteria for selection were 1) participants should hold senior position in KTOs of UK based universities; 2) university's research ranks should spread evenly in the range from 1 to 120, where the university research rank data were from Research Councils. 3) KTOs locations should cover all areas in the UK, and their size and age were also evenly distributed among all KTOs in the UK. The latter two criteria were

designed to cover the maximum possible range of diversity, which were partly taken from sample selection criteria used in previous empirical study. In this research, 80 universities across the UK were selected and in each KTO 2-3 leading practitioners were identified. Hence in total 205 senior knowledge transfer practitioners were considered. All postal address information was obtained from public information on websites of KTOs.

This study took advantage of postal survey, through which 205 survey packages were posted to participants' working address. In the package, apart from the Q statements, Q sort instructions and personal information questionnaire, participants were also informed of the following contents: 1) name and position of researcher, 2) the purpose of the study was to map the perceptions of KTOs' leading practitioners concerning the management issues, 3) the researcher was interested in what participants thought about KTO management issues, for which there were no right or wrong answers, just differences in perceptions, 4) participation in the study was voluntary, and 5) all data would be treated with confidentiality. Moreover, after the Q-sort, participants were asked to answer why they put certain statements in extreme positions of the Q sort sheet. The survey consisted of two consecutive rounds. Two weeks after the arrival of the first mail return was set as the first round. At this point 28 completed survey packages were received. After that, in the second round another 177 packages were sent to the rest of participants who did not response in the first round. It took another two weeks time to receive another 10 finished survey packages. Among 38 (18.5%) received packages, 7 (18%) were discarded as unuseful, primarily due to confusion in completing the Q sort sheet and some due to the complexity of the entire Q-sorting process.

After collecting the survey data, 5 follow-up interviews were taken by telephone. The interviews have two main purposes, 1) to test the reliability of the survey, in which they were asked to redo the Q-sort; 2) to obtain more information and comments about the extreme statements. The follow-up interviews supported the reliability of the study, in each of the redo Q-sort, less than 6 (12.5%) statements were placed in different positions.

4.5. Data analysis

In contrast to most qualitative methods, collected data using Q methodology are open to numerical analyses. Quantitative data reduction helps to discover patterns and connections that otherwise might be passed over by non-statistical methods of data analysis. In Q-methodology, data analysis uses correlation and by-person factor analysis which emphasizes that the statistical analysis is not performed by variable, trait, or statement, but by person.

In this research, data analysis was conducted utilizing PQMethod 2.0, the software specifically developed for the purposes of Q methodology data analysis. The mathematical and statistical calculations are similar to these of other software programmes such as SPSS. However PQMethod is appropriate for use in this study because data entry and reporting functions have been purposively programmed to facilitate the procedure for Q methodology.

First, correlations of 31 Q sorts were computed by PQMethod to provide a preliminary assessment of how each Q sort correlates with one another. Next, as suggested by Brown (1980), Centorid factor analysis was performed to obtain un-rotated factors. Varimax rotation was then performed to reveal rotated factors. Eight un-rotated factors were extracted and these factors were then rotated to a simple structure utilizing the Varimax rotation. The Varimax of orthogonal rotation is most frequently employed in Q research (McKeown & Thomas, 1988). Factor loadings of these rotated factors were examined, and the factors were further manually rotated to better reflect the interrelationship of 31 Q-sorts based on their correlations. Automatic pre-flagging was performed using PQMethod to highlight each Q sort's association with identified patterns. The procedure of flagging is conducted by examining Q sorts' factor loadings to determine which revealed factors they are associated with.

Of the potential solutions, a four factor solution was determined to be the most satisfactory, as it resulted in more participants loading significantly on a single factor. Moreover the four factor solution was chosen over three because four factors accounted for over 8% more variance over the three factor solution. The four factor solution accounted for 59% of the variance. Furthermore, the four factors solution was selected over five factors because four factors solution had the most significant Q-sorts, 24 out of 30 Q-sorters have significant loadings on the four factor solution. **Table 7** displays the rotated factors for this solution.

In determining whether or not a factor is 'significant' is based on a variety of criteria. Of the statistical options, the most common practices is to use eigenvalues criterion(McKeown & Thomas, 1988), whereby a factor's significance is estimated by the sum of its squared factor loadings. The conventional enginvalue criterion for determining significance is its value being greater than 1. In this study, eigenvalues for factors were Factor1: 13.7416 Factor2: 1.6953 Factor3: 1.6525 Factor4: 1.3846 respectively.

Table 16 Rotated factor loadings

Sorts	Factor 1	Factor 2	Factor 3	Factor 4
1	0.3185	0.3534	0.6741*	0.1139
2	0.6988*	0.3539	0.1684	0.3735
3	0.4964	0.3409	0.3183	0.2482
4	0.507	0.4517*	0.1669	0.2843
5	0.0854	0.3433	0.3571	0.6720*
6	0.6767*	0.1677	0.2435	0.1071
7	0.4593*	0.0038	0.6611*	0.3291
8	-0.0225	0.7066*	0.0773	0.2952
9	0.6912*	0.3416	0.0769	0.3534
10	0.5501*	0.0907	-0.1242	0.4462*
11	0.4751*	0.6582*	0.0353	0.0437
12	0.5017*	0.3101	0.298	0.2405
13	0.6926*	0.1354	0.0676	0.0869
14	0.2141	0.1227	0.2683	0.6621*
15	0.6300*	0.4250*	0.1565	0.3779
16	0.6858*	0.4063	0.1696	0.2123
17	0.4031	0.3133	0.3131	0.2025
18	0.3933	0.6231*	0.3236	-0.0524
19	0.7035*	0.0738	0.2354	0.113
20	0.3417	0.1268	0.2894	0.6229*
21	0.4384*	-0.2408	0.314	0.3485
22	0.1558	0.3789	0.5706*	0.1395
23	0.0494	0.0514	0.7295*	0.0851
24	0.1939	0.4952*	0.273	0.5235*
25	0.6551*	0.3082	0.2237	0.1099
26	0.2646	0.6578*	0.215	0.2995
27	0.351	0.5024	0.2436	0.297
28	0.5763*	-0.0133	0.3289	0.2185
29	0.6455*	0.4474*	0.3642	0.2022
30	0.2243	0.2572	-0.1939	0.5602*
31	0.3276	0.3023	0.5212*	0.0531
% explained variance	23	14	11	11

(indicates defining sort for factors)*

Statistically, a factor array is regarded as most representative of each factor. PQMethod can automatically 'flag' or distinguish those actual sorts which define a factor based on factor loadings. It is noteworthy that the factor loadings are understood as 'in effect correlation coefficients', which indicates the extent to which each Q sort is similar or dissimilar to the composites of the factor array (McKeown & Thomas, 1988). The factor loadings is calculated with the formula for zero-order correlation coefficients, i.e., SE = $1/(\sqrt{N})$, where SE is the standard error and N is the number of Q-sort statements. Since there were 48 statements in this study, the standard error comes out to 0.16 (SE = $1/(\sqrt{48}) = 1/6.92 = 0.16$). Correlations are considered to be statistically significant at the 0.01 level when they are in excess of 2.58 multiplied standard errors, or $2.58 \times (SE) = 2.58 \times 0.18 = 0.413$. Hence in this study, the loadings matching or exceeding 0.413 are considered statically significant at the 0.01 level. Ultimately, the Q-sorts that PQMethod flagged as defining sorts were utilized to interpret these four factors. In this study, the number of Q-sorts to define each factor were factor 1 had 17 sorts greater than 0.413, factor 2 had 9, factor had 5, and factor 4 had 6. And there were three sorts which did not significantly load on any of the four factors.

It is important to point out that Some Q sorts' associations, however, are more difficult to determine because they are significantly loaded with two factors. When a Q sort has two significant factor loadings, it means that the Q sort, to a certain degree, represents the views of two factors. In order to determine the association of these Q sorts, their two significant loadings were compared to see if one factor loading is much higher than the other one in making subjective decisions. Examples can be found in Q-sort No. 11, No. 24 and No.29. For Q sorts in which the difference is not large enough to determine which factor they should be assigned to, they will not be assigned to any of the factors.

As for PQMethod, it follows the process mentioned above and utilizes these sorts that are recognized as defining each factor to develop a factor array for each factor. These arrays serve as a model Q-sort representing each factor's perspective, which are listed in **Appendix 8.** In most research applications, factor interpretation is conducted on the basis of factor loadings. In Q methodology, however, the interpretations are based primarily on the factor scores(Brown, 1980; McKeown & Thomas, 1988). The weight of each Q-loading of a specific factor was calculated by expressions given by Spearman(1927)[3]:

$$\omega = \frac{f}{1 - f^e}$$

The ω is the factor's weight and f serving as factor loading. As a result, those sorts more

[3] Reference is cited in McKeown, B., & Thomas, D. 1988. **Q methodology.** London: Sage.

highly associated with the factor weigh more heavily in the factor merged composite array. These factors' array scores are calculated as *z-scores* and are then converted to the rank numbers used in the Q sorts array, which in this study they are ranging from -4 to +4. These arrays serve as the basis for interpreting each factor's perspective, which are illustrated in **Appendix 8.**

5. Results and discussions

5.1. Description of participants

Participants in this study were all believed to have leading or senior position in university based KTOs in the UK. Among 31 survey packages used in this study, 11 (35.5%) participants stated they had hybrid background, 16 (51.6%) said they had business background, and only 4 (12.9%) acknowledged they have academic background. Their average year in the current position is 4.3 (SD=2.4). Most KTOs have experienced restructure since 2003, and average number of staff in each KTO is 31.6 (SD=22.82). In addition, the participants affiliated universities cover main regions including England, Scotland and Wales. The appendix 5 lists the information regarding the description of participants.

5.2. Factors interpretations

Four factors or the 'patterns of perspectives' have been generated from the quantitative analysis procedure. These four factors help group similar perspectives together. The factors were then interpreted utilizing several sources. First, an overall factor array displays the *z-values* associated with each factors. Second, statements that distinguished factors helped to define factors. Lastly, literatures and narratives collected from previous case study stage and follow up interviews assisted in understanding the factors.

In the interpretation stage, it was found that each factor can represent a theme of perspective upon the management of KTO. Consequently, each factor was then named by qualitative analysis on significant and distinguishing statements in each factor. In this process, the previous interview data were also used to facilitate the interpretation.

Perspective 1: Interconnectivity oriented management

This perspective is highly distinctive for the strength of its interconnectivity orientation. It shows particularly strong support for interconnectivity among university and internal and external entities. Statements demonstrate concerns by practitioners regarding the human resource management (S5), policy and strategy (S7, S10, and S2), which were

Table 17 List of Factors

Statements	Factor 1		Factor 2		Factor 3		Factor 4	
	z-value	rank	z-value	rank	z-value	rank	z-value	rank
1	0.81	16	1.27	4	-0.18	26	-1.16	41
2	1.38	5	0.29	23	0.64	15	0.63	12
3	0.89	12	0.86	8	1.19	5	0.98	9
4	1.3	6	1.4	3	0.82	10	0.52	16
5	1.5	2	0.24	24	0.23	20	0.57	15
6	0.93	10	-0.03	28	0.18	24	0.15	24
7	1.62	1	0.84	11	1.14	6	-0.42	32
8	0.83	13	0.08	26	0.72	13	0.37	19
9	0.81	15	1.06	6	-0.83	39	0.36	21
10	1.48	3	0.86	9	0.76	12	1.84	1
11	0.78	17	0.39	22	0.65	14	0.88	10
12	0.92	11	2.19	1	1.02	8	0.61	13
13	-0.13	27	1.75	2	1.61	4	1.08	6
14	0.83	14	0.98	7	0.18	23	0.2	23
15	1.29	7	0.44	21	0.08	25	0.36	21
16	1.14	8	0.55	17	0.37	17	0.47	17
17	1.02	9	0.84	10	0.18	23	0.14	25
18	0.46	19	0.61	15	0.95	9	0.6	14
19	1.42	4	0.46	20	2.01	2	1.38	4
20	0.04	24	0.61	16	0.19	21	0.01	27
21	0.15	21	0.52	19	0.81	11	1.77	2
22	0.12	22	0.54	18	-0.22	28	-0.53	33
23	0.05	23	-0.56	33	-0.43	30	0.39	18
24	-0.01	25	0.22	25	-1.24	44	1.03	8
25	-0.12	26	0.81	13	1.06	7	1.61	3
26	-0.59	32	-1.15	40	-1.06	41	-1.6	44
27	-0.33	30	-1.42	44	-1.12	42	0.03	26
28	0.17	20	-0.55	32	-0.76	37	0.2	23
29	-0.66	34	-0.27	30	-0.6	33	1.07	7
30	-1.62	46	-1.27	41	-0.72	35	-1.15	40
31	-0.92	37	-1.88	48	0.58	16	-0.62	36
32	-0.49	31	-0.85	36	2.19	1	-0.19	31
33	-1.57	45	-1.47	45	-1.72	47	-1.24	42
34	-1.09	40	-1.06	38	0.24	19	-0.58	34
35	0.55	18	-0.05	29	1.79	3	1.36	5
36	-1.2	43	-1.06	39	-0.82	38	-0.82	38
37	-1.47	44	-0.78	35	-0.21	27	-0.62	36
38	-1.68	48	-1.29	42	-1.13	43	-0.04	29
39	-0.6	33	-0.02	27	-0.29	29	-0.99	39
40	-1.18	41	-1.4	43	-1.56	46	-1.64	46
41	-0.93	38	-1.52	46	-1.55	45	-0.78	37
42	-0.2	29	0.83	12	-0.87	40	0.85	11
43	-0.86	36	0.63	14	-1.96	48	-1.64	46
44	-0.81	35	1.1	5	-0.58	31	-0.14	30
45	-1.19	42	-1.62	47	-0.72	35	-1.27	43
46	-1.66	47	-0.36	31	-0.58	32	-1.8	47
47	-0.19	28	-0.76	34	0.28	18	-0.03	28
48	-0.97	39	-1.03	37	-0.74	36	-2.2	48

regarded ought to be 'open' in building connection with stakeholders. Moreover, it is important to point out that albeit the participants stress the collaboration with stakeholders within the territory of university, more emphasis is given to the external stakeholders, as in statement S45 and S33 participants rejected the view that university KTOs should focus more on internal issues.

Apart from the emphasis on the interconnectivity, this cluster of perspectives also places emphasis on the importance of flexibility of the stakeholders' interactions in managing the KTO. For example, in Statement S37 and S38, practitioners are against the view of 'control' and 'audit' but are in favour of empowerment and distributed leadership. Additionally the negative value of statement S46 also indicates that practitioners value the capability of communication and building connectivity. In conclusion, while other perspectives show emphases on other areas of management, this perspective highlights the importance of the interconnectivity with internal and external stakeholders.

Table 18 Perspective 1

Statements	*Z* Score
5. KTO should empower, encourage and enable the KTO people to enhance the interconnectivity with university, industry and other stakeholders	1.577
7. KTO's policies should support models of managing IP with more open and proactive characteristics instead of just protecting	1.567
10. Ensuring, supporting and managing stakeholders' engagement in university knowledge transfer activities is a core mission of KTO	1.501
2. KTO's strategic policies should support the connectivity of university R&D activities with university's internal and external entities	1.467
19. KTO's strategic intention and efficiency in building and maintaining networks has significant impact on the effectiveness of knowledge transfer	1.362
15. The University's knowledge transfer business model should be able to balance different stakeholders' requirements and expectations	1.263
45. In the KTO performance measurement the interconnectivity with stakeholders should be of less importance than internal team working	-1.310
37. The organizational empowerment and distributed leadership should be constrained by a control regime to achieve the purpose of protecting university's IPR	-1.348
33. The focus of KTO operations is mainly to deal with and handle university administration and academic researchers activities and issues	-1.489
4. KTO cannot make all stakeholders happy and therefore the mobilisation of stakeholders is neither practical nor essential	-1.717
38. The primary role of KTO's knowledge transfer staff is to audit, monitor and control the knowledge transfer activities	-1.725
46. The senior staff's capability to control the resources is more important than capability for communication and connectivity	-1.726

Perspective 2: performance leading management

In distinction to the interconnectivity focused perspective, this perspective mainly covers issues regarding performance as well as efficiency and effectiveness for instance statement S5 and S44 show the concerns of participants regarding the effectiveness and efficiency. Statements S12, S43 raise issue of the financial performance of KTO, and S13 reflects the importance of non-financial incentives for stakeholders. Non-financial targets are of more importance such as S41 criticizes the conventional measurement system is not sufficient. Moreover, in terms of the managerial issues associated with the performance concerns, S4 S40 and S27 gives emphasis on communication, flexibility and networking respectively. This perspective reflects practitioners' concerns that one of the priorities is placed to be the performance issues. This is also mirrored by one major topic – performance of KTOs and university knowledge transfer – in existing research of the university knowledge transfer and KTO management (Phan & Siegel, 2006; Siegel et al., 2007; Siegel et al., 2003b).

Table 19 Perspective 2

Statements	*Z* Score
12. Attracting and generating funding from all available sources to proactively exploit the university knowledge should be among main missions of KTO	2.195
13. Besides pay, many other non-economic factors motivate KTO individuals in contributing to the university knowledge transfer	1.755
4. KTO's strategy should be focused on establishing and maintaining effective networks with internal and external stakeholders	1.403
1. It is essential for KTO to set up a vision that values inflow and outflow knowledge (to-from university) equally	1.269
43. The return on investment is a critical factor to measure the efficiency of KTO	1.102
9. KTO's operations strategy should be centred around identifying and valuing all stakeholders' expectations and contribution	1.064
40. The channels and business models of university knowledge transfer are relatively fixed and therefore flexibility to change of business model is not a priority for the KTO	-1.402
27. The focus of organizational strategy and structure should be to improve the level of internal communication	-1.417
33. The focus of KTO operations is mainly to deal with and handle university administration and academic researchers activities and issues	-1.470
41. Standard measurement system introduced by government for university knowledge transfer is sufficient for KTO management	-1.518
44. In the KTO performance measurement the interconnectivity with stakeholders should be of less importance than internal team working	-1.621
31. Internally focused strategy will make the KTO work more efficient and effective for getting better results	-1.875

Perspective 3: Internal focused management

The distinctive character of internal focused management is established on managing internal capabilities and stakeholders' interests. As opposed to the previous two perspectives which are strongly in favour of interactions with external stakeholders and networking, this perspective turns its focus on the internal management issues, which can be demonstrated by the two highest ranked statements: S35 and S32, which value the internal resources and internal stakeholders. Moreover the capabilities of staff (S38) and practitioners (S21) are also of great interest by this perspective. Importantly, the internal focused management does not necessarily mean that this perspective neglects or rejects the importance of 'opening' to external stakeholders.

Table 20 Perspective 3

Statements	*Z* Score
35. The KTO activities depend highly on the availability of internal resources	1.955
32. Mobilising and motivating academic researchers to engage in knowledge transfer is more important than working on external networks	1.872
19. KTO's strategic intention and efficiency in building and maintaining networks has significant impact on the effectiveness of knowledge transfer	1.485
13. Besides pay, many other non-economic factors motivate KTO individuals in contributing to the university knowledge transfer	1.455
12. Attracting and generating funding from all available sources to proactively exploit the university knowledge should be among main missions of KTO	1.426
21. The KT practitioners capabilities in mediating and resolving conflicts are essential to successful governance of knowledge transfer activities	1.259
35. Measures and methods for auditing the efficiency of knowledge transfer need to take into account the difference between applied business models	-1.235
38. The primary role of KTO's knowledge transfer staff is to audit, monitor and control the knowledge transfer activities	-1.524
41. Standard measurement system introduced by government for university knowledge transfer is sufficient for KTO management	-1.751
40. The channels and business models of university knowledge transfer are relatively fixed and therefore flexibility to change of business model is not a priority for the KTO	-1.842
43. Amount of raised funds should be the foremost criterion for measuring the performance of KTO	-1.971
33. The focus of KTO operations is mainly to deal with and handle university administration and academic researchers activities and issues	-1.971

Perspective 4: Reconciliation oriented management

With this perspective, practitioners place importance on the balance between different stakeholders (S25, S30), distinctive business models (S10 and S24) and various performance indicators (S46 and S43). Like the interconnectivity perspective, this perspective also emphasises the importance of collaborating with stakeholders (for

example S10), but mainly it puts emphasis on the balance between stakeholders (S21, S30). It also exhibits a view of balance between financial and non-financial performance indicators. This perspective gives the importance of protection of IP, which can be seen as the base of reconciliation.

Table 21 Perspective 4

Statements	*Z* Score
21. The knowledge transfer practitioners capabilities in mediating and resolving conflicts are essential to successful governance of knowledge transfer activities	1.909
10. Ensuring, supporting and managing stakeholders' engagement in university knowledge transfer activities is a core mission of KTO	1.716
11. Protection and retention of the intellectual property are essential elements of KTO mission	1.643
24. Measures and methods for auditing the efficiency of knowledge transfer need to take into account the difference between applied business models	1.263
19. KTO's strategic intention and efficiency in building and maintaining networks has significant impact on the effectiveness of knowledge transfer	1.193
29. The KTO management should take the university, its administration and academic researchers as priority stakeholders	1.177
40. The channels and business models of university knowledge transfer are relatively fixed and therefore flexibility to change of business model is not a priority for the KTO	-1.419
46. The senior staff's capability to control the resources is more important than capability for communication and connectivity	-1.435
30. KTO cannot make all stakeholders happy and therefore the mobilisation of stakeholders is neither practical nor essential	-1.494
43. Amount of raised funds should be the foremost criterion for measuring the performance of KTO	-1.793
25. KTO's strategy and activities should remain stable by incorporating only a few established business models	-1.886
48. The economic indicators of exploiting university generated IP could represent the entire performance level of knowledge transfer	-2.027

5.3. The consensus beliefs

The most consensus statements illustrate that the participants do not believe the internal focused and the inflexibility are useful for university knowledge transfer office management, for example statement S4 is one of the statements with most consensuses from practitioners. Additionally focuses only on internal stakeholders (S33) is opposed by most participants.

In the meantime they support the flexible management and transparency of information. The consensus statements also demonstrate that the participants believe the networking (See S4, S19 and S32) is critical in managing the knowledge transfer. The consensus statements also indicate the business model is one of the critical elements in

the knowledge transfer management. S15 stressed the importance of business model in managing stakeholder engagement, and S25 takes into account of the business model as a performance measurement issue.

Table 22 Consensus statements

Statements	Factor 1		Factor 2		Factor 3		Factor 4	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
3	2	0.89	2	0.86	3	1.19	2	0.98
4	3	1.3	3	1.4	2	0.82	1	0.52
8	1	0.83	0	0.08	1	0.72	1	0.37
11	1	0.78	0	0.39	1	0.65	2	0.88
14	1	0.83	2	0.98	0	0.18	0	0.2
16	2	1.14	1	0.55	1	0.37	1	0.47
18	1	0.46	1	0.61	2	0.95	1	0.6
20	0	0.04	1	0.61	0	0.19	0	0.01
23	0	0.05	-1	-0.56	-1	-0.43	1	0.39
33	-3	-1.57	-3	-1.47	-4	-1.72	-2	-1.24
36	-3	-1.2	-2	-1.06	-2	-0.82	-2	-0.82
40	-2	-1.18	-3	-1.4	-3	-1.56	-3	-1.64
41	-2	-0.93	-3	-1.52	-3	-1.55	-2	-0.78
45	-2	-1.19	-4	-1.62	-1	-0.72	-3	-1.27

5.4. Correlation among factors

After the Varimax rotation procedure, factors were correlated ranging from 0.45 to 0.69, where factor 1 and factor 4 had the highest correlation and factor 2 and factor 3 have the lowest correlation, which is illustrated in **Table 5.**

Table 23 Correlations between Factor Scores

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	1.0000	0.6903	0.5815	0.6197
Factor 2	0.6903	1.0000	0.4581	0.5387
Factor 3	0.5815	0.4581	1.0000	0.5960
Factor 4	0.6197	0.5387	0.5960	1.0000

The relationship between factor 1 and factor 2 shows that although perspective 1 and perspective 2 showed distinct focuses on the management of KTOs, they both indicate

that the direction of management is towards the 'open' university knowledge transfer suggested in previous chapter. For example, statements 4, 7, 33 and 34 are all exhibiting the agreements among participants regarding interconnectivity with external partners, and disagreements about the concentration on internal issues and less business model focused management. These statements are showing a similar ranking and least difference in z-score pertaining to each factor.

Moreover, perspective 2 and perspective 3 differed more than differences between any two of other perspectives. Perspective 2 is performance leading which focuses on the effectiveness and efficiency of KTO management, but do not feature prominently in Factor 3. For instance, seen from the statements below, perspective 2 strongly disagree internal focussed strategy in statement 31 and 45, whereas perspective 3 is almost neutral to these statements. And in relation to the statement 35, which describes a judgement of internal focused strategy, perspective 3 is strongly supportive while perspective 2 is neutral.

Table 24 Distinctive statements between Factor 2 and Factor 3

No.	Statements	Factor 2 score	Factor 3 score
9	KTO's operations strategy should be centred around identifying and valuing stakeholders' requirements and contribution	3	-1
31	The internally focused strategy will make the KTO work more efficiently and effectively for getting better results	-4	0
35	The KTO activities depend highly on the availability of internal resources	0	4
45	In the KTO performance measurement the interconnectivity activities are and should be of less significant importance than internal resource management	-4	-1

6. Summary

In this chapter, the Q methodology, a systematic means for study of subjectivity, is adopted to investigate the perceptions of university knowledge transfer practitioners on the subject. By utilization of the Q based survey of university knowledge transfer practitioners in KTOs, the research discovers the pattern of practitioners' perspectives in the knowledge transfer management. Four shared perspectives were found: 1) interconnectivity oriented management, 2) performance led management, 3) internal focused management, and 4) reconciliation oriented management. These four perspectives share a central concern that interconnectivity and flexibility are the key characteristics of KTO management. Furthermore, the business model focused management is also supported by most practitioners.

Importantly, the findings of this study reflect positively on the findings and understandings from previous case study stage in number of attributes: 1) focusing on the inter-organizational relations and interactions is deemed as the trend of development of KTO management. Since innovation process is poised to be a social process which involves extensive interactions between innovation stakeholders, the KTO practitioners are, according to the Q study, also shifting their focus on the issues such as networking, inter-organizational connections, and open cooperation and collaborative relationships; 2) Features of university open knowledge transfer are widely advocated at a perception level by practitioners and KTO managers which indicate preparedness of HEIs for shifting to the new structures of modernised knowledge transfer systems 3) The complexity associated with the perceptions reflected in the combination of the identified groups could correspond with the diversity and complexity of technology transfer system identified theoretically as characteristics of university knowledge transfer system. In the same time although most participants believe that building the inter-organizational connectivity is critical for KTOs and their success, there still exit viewpoints supporting internally focused approach to KTO management. For instance, to serve stakeholders within the university territory, as a main priority for KTO, is still the main focus of some participants.

In addition, this chapter also illustrated that Q analysis not only maps practitioners' perceptions of the KTO management and provides sharper insight into participant preferred management directions, but also explicitly outlines areas of consensus and divergence by practitioners in term of the 'open' university knowledge transfer.

CHAPTER VII. DISCUSSION AND CONCLUSION

1. Introduction

The effective and efficient management of KTOs is believed to be of great significance in the success of university's knowledge transfer business. However in the context that the university knowledge transfer system is characterized by complexity, multiplicity and dynamics, the understanding of the development of KTO management remains limited. This thesis therefore aimed to analyze the emerging landscape of management practice of university KTOs across the UK and perceptions of leading practitioners' concerning management issues of KTOs. Following the theoretical and empirical studies presented in previous chapters, this chapter intends to conclude the entire research via elucidating arguments proposed in this research, and discussing further thinking and implications in light of the research results. In addition, in this chapter, research limitations and suggestions for further research are also discussed.

This chapter is accordingly structured as follows. The first section summarizes the results of studies undertaken in this research, which respond to research questions in light of the results of studies in a collective way. The next section of the chapter provides discussions on the empirical studies presented in **Chapter 4** and **Chapter 5** in light of the theoretical studies described in **Chapter 2.** Following this, in the third section theoretical and practical implications of these results are presented in reflection to the system thinking and governance mechanisms. The last section reviews the limitations of the research and makes suggestions for future research directions.

2. Summary of results

This research focuses attention on the management of university KTOs, which has been viewed as a critical factor for successful university knowledge transfer, and still remains a void in the extant literature. The research therefore aimed to fill the void in literature, in particular with respect to the managerial issues including strategy, process, people and platform of KTOs. Generally, this study presented a new insight into the emerging landscape of the management practice and related practitioners' perceptions regarding the university KTOs management.

The theoretical study presented in **Chapter 2** sought to provide a comprehensive view of the current university transfer system and identify the salient features of university

knowledge transfer. By reviewing extant literature, this study proposed a value chain model to describe the university knowledge transfer system. This value chain model clusters the interactions between university and industry into three stages of categories: knowledge acquisition, knowledge processing and knowledge dissemination. This study also summarized salient features of current university knowledge transfer system including multiplicity, complexity and dynamics. Furthermore, in terms of university KTOs, by delineating KTO's development from a simple liaison office to a main player in the system of knowledge transfer and analyzing the roles KTOs are playing, this study suggested that KTOs are serving as the governing bodies of the university knowledge transfer system, which dedicate themselves to mobilize a variety of stakeholders to engage in knowledge transfer, coordinate their knowledge transfer activities, and align their strategies. Importantly, this study also suggested that the university knowledge transfer has been significantly influenced by the changing environmental factors, including mainly the changing government policy from merely supporting research to knowledge dissemination focused, and business innovation is shifting from technology focused to business model focused. In addition, the evolution of university from conventional to entrepreneurial mode has also been studied. This study revealed that universities have changed considerably in terms of adopting a wide range of channels of interactions with business, and dealing with a variety of stakeholders.

The first empirical study aimed to investigate the cross-institutional patterns of KTO management and elucidate the landscape of the KTOs management. This study analyzed the unbalanced development of KTO management in the context that universities are in the state of transition from conventional education and research based to entrepreneurial ones, and innovation has evolved from technology focussed to business model focussed. Some KTOs are leading in establishing connection with internal and external stakeholders, adopting new business models, and being proactive in dealing with knowledge transfer, whereas some others adhere to the legacy mission of university and therefore are simply regarding the knowledge transfer as a peripheral stream of activities. This study identified and summarized the differences of managerial issues among selected cases and consequently developed a three-level spectrum to delineate this situation. It is worth noting that in most cases the style of management just accommodates strategies determined by university and key stakeholders. In the course of the study, some critical issues of concerns to practitioners are also ascertained such as structure, intellectual property portfolio management, performance metrics, and

business models. Moreover, this study has utilized Grounded Theory to discover five general features of KTO management, especially in the leading KTOs identified in earlier stage of the study. These features are not random, rather systematically cover main concerns of the KTO management team and university administrations. These features also reflect the development of the entrepreneurial university towards a more 'open' system, which means universities are becoming more closely integrated into the innovation system. Given that these features correspond to the principles of the open innovation paradigm suggested by Henry Chesbrough (2006b), they were named as principles of the 'open knowledge transfer'.

The second empirical study introduced Q methodology to examine the perceptions of leading practitioners for the purposes of understanding their patterns of cognitive preference towards the 'open knowledge transfer' management proposed in the first empirical study. This study provides empirical evidence that the perceptions of leading university knowledge transfer practitioners are showing a variety of characteristics. This Q methodology based study revealed four perspectives of leading practitioners' attitudes towards managerial issues of the 'open knowledge transfer'. These four perspectives cover subjects both pros and cons towards the management of 'open knowledge transfer', and also identify the strategic management preference of leading practitioners. In addition, this study illustrates the utilization of Q methodology in the area of university knowledge transfer and suggested the criteria for evaluating the quality of Q study.

These three studies are interconnected. The theoretical study provides underpinnings to the empirical studies and the results of first study initiates the second study. In the meantime, results of the second study also reflect findings of the first empirical study and the features of knowledge transfer system summarized in the theoretical study. Ultimately these three studies converged into two main perspectives. Firstly, these studies revealed diversity and complexity features of university knowledge transfer from different angles. The Grounded Theory based empirical study revealed three different styles of management which mirror the unbalanced development of entrepreneurial universities across the UK, and the Q methodology based study also indicated that the practitioners' perceptions towards the management issues are at variance including both internal management focused and interconnectivity focused. Likewise, the theoretical study summarized the features of university knowledge transfer system including

'complexity' and 'multiplicity'. In light of these features, these studies suggested a systematic view of university knowledge transfer. Secondly, these studies all imply that the trend of university knowledge transfer is moving towards 'openness'. In the theoretical study, the analysis on the entrepreneurial university emphasizes the blurred boundaries between university and business. And the features of university knowledge transfer also require university to be 'open' to multiple-stakeholders and a wide spectrum of business models. The first empirical study also proposed the 'open features' of university knowledge transfer management and the second empirical study also summarized the consensus of leading practitioners towards active interactions with stakeholders and the positive attitudes towards business models.

3. Contributions to knowledge

The research results included in this thesis indicate the contributions of this thesis to knowledge. Although this thesis focuses on the 'narrow' issue of KTO management, it assisted to broaden the perceptive of knowledge of university knowledge transfer in general and introduced a new methodology in this research area. The contributions of the thesis can be summarised as following:

1) This thesis has given a systematic view to the roles and missions of university knowledge transfer offices. Traditionally the roles and missions of KTOs were often defined based on simple transactions between two partners, namely knowledge provider and user (Macho-Stadler et al., 2007; Siegel et al., 2003b).This thesis has made an effort to broaden this view. Firstly in the theoretical study, this thesis has summarised three features of the knowledge transfer system, which include multiplicity, dynamics and complexity. Secondly, underpinned by the theoretical study, this thesis presented the roles and missions of KTOs from a multi-stakeholders perspective and a value based inter-organisational interactions and collaboration view.

2) This thesis has highlighted the significance of management issues in association with university knowledge transfer offices, and revealing the emerging landscape of the management of knowledge transfer offices. In extant literature, the management issues of KTOs remain fragmented and the significance of such management issues has gained little attentions. This research has filled this void and utilized the value chain model to connect the management issues with the system of university knowledge transfer. In addition to highlight the significance of the management of

KTOs, this thesis has also conducted a Grounded Theory based research to reveal the emerging landscape of the management in association with university based KTOs, which is conducive with the changing status of entrepreneurial university since World War II (Etzkowitz, 2003a; Tuunainen, 1999).

3) This thesis has considered the cognitive aspect of university knowledge transfer in research. Through the literature survey, a void has been identified: in the area of research into university knowledge transfer, the cognitive aspects and cognition issues remain neglected. Through the review of strategic management literature, this thesis connected the cognitive issues with the management of university knowledge transfer. Based on the theoretical underpinnings, this thesis has conducted an empirical study to reveal the patterns of practitioners' perceptions regarding the management issues of KTOs. The results of this empirical study have reflected the emerging landscape revealed in the Grounded Theory based study. The cognitive aspect of management also offers a new angle to analyze and understand the development of university knowledge transfer.

4) This thesis has introduced the novel application of the Q methodology in the territory of research into university industry links and knowledge transfer. Methodologically, the contribution of this thesis is the utilization of Q, a methodology that has been widely used in psychology, communication and politics to good effect. A contribution of this thesis is it not just identified the Q methodology, but also illustrated the application of the methodology to demonstrate its appropriateness in the domain of research into university industry links and university technology transfer.

4. Discussions and further thinking

The results of this research rest on two main areas, namely the systematic view of university technology and the open knowledge transfer system. Accordingly, the discussion of the research pivots on these two issues shown as below:

4.1. The systematic view: reflection on governance and transaction value

The empirical studies of this research demonstrated that some criticisms KTOs suffered ought to be attributed to some defects pertaining to the entire university knowledge transfer system, such as the complex decision making process, and lack of sufficient

information exchange among stakeholders. Based on the analysis of KTOs' rationales, roles and positions in the system of university knowledge transfer, the theoretical study suggested that KTOs are serving as the governing body of the system. The governance mechanisms are therefore of great importance to the entire system that involves stakeholders with different interests. However the understanding of the governance in this area is neither explicit nor precise. Based on results of this research, this section discusses the governance of university knowledge transfer system and the role KTOs are playing from the governance perspective.

The use of the term of governance showed a relatively new fashion in recent years, especially along with the emergence of globalisation, deregulation of government restrictions, as well as the network and knowledge based economy, the governance has expanded its territory to cover a wider spectrum of areas including economics, public administration, corporate management, etc (Pierre, 2000). Despite that the concept has been accepted and used widely, the term governance remains relatively imprecise, i.e. it has multiple meanings and there is a good deal of ambiguity in its different usages(Hamaker, 2003; Hirst, 2003; Pierre, 2000; Rhodes, 2003). Some researchers have attempted providing an overarching definition of governance. For example by suggesting five definitions of governance, Hirst (2003) points out that governance is the 'post-political' alternative to the conventional centralised means of steering and coordinating the social system. Rhodes(1996) summarises the six usages of governance, and defines governance as self-organising interorganisational networks. These networks are characterized by interdependence between organisations, and continuing interactions between network members. Similarly, Jon Pierre(2000) defined governance as 'sustaining coordination and coherence among a wide variety of actors with different purposes and objectives'. In general, the language of governance tells a distinctive story of fragmentation, networks, and dependence which contrasts sharply with the language of corporate management and market(Rhodes, 2003).

Among a variety of definitions governance has, Jon Pierre's(2000) definition is regarded appropriate to accommodate the system of university knowledge transfer as it emphasizes the network and interorganisational interactivity features the system has. As mentioned above, the university knowledge transfer involves multiple stakeholders, usually including the government, university administration, researchers, business and knowledge intermediaries, who work together as a value network. These stakeholders,

who have a variety of objectives and different resources, work with each other to achieve their targets. In this sense, the boundaries and responsibilities for fulfilling knowledge transfer targets are blurred (Etzkowitz, 2003b), the institutions are power-dependent and resulting networks are somewhat autonomous and self-governing. In the knowledge transfer network, there is no centralised institution capable of directing and administrating the entire system, hence the traditional way of directing or controlling such network seems not to work effectively (Chapple et al., 2005; Feller et al., 2002b; Phan & Siegel, 2006; Thursby & Kemp, 2002), which calls for a fragmentation style of coordination and external dependence. The governance can meet this requirement and accommodate the situation. Additionally, the governance of knowledge transfer also changes the way of decision making, communication and motivating stakeholders from the angle of interorganisational interaction. For instance, the first empirical study revealed that the distributed organisational structure has been adopted, qualitative performance measurement has been considered, and universities started resorting to new intermediaries to transfer their technologies.

The governance of university knowledge transfer can be seen as the result of the second academic revolution (Etzkowitz, 2003a) that means universities commit to the commercialisation of its knowledge and became more proactive in interaction with external stakeholders like business and wider community. In this sense, the key issue of governance is to coordinate and align the stakeholder's strategy and operations. The governance concept of university knowledge transfer offers a new perspective to study the mechanism of the organisational interactivity in the knowledge transfer system. Moreover, the governance concept also presents a simplified but comprehensive way to understand university knowledge transfer, focusing on the inter-organisational interactivity among a variety of stakeholders.

In terms of KTOs, this research suggested that KTOs are dedicating to mobilize a variety of stakeholders to engage in knowledge transfer, coordinate their different activities, and align their strategies. KTOs are therefore understood as the governing body of the system. As such, the goal of KTOs is not only to create value for stakeholders by themselves, but also to mobilize stakeholders to create mutual value from interactions. From this perspective, the value of KTOs exists in the maximization of the transaction value through inter-organizational interactions. In this sense, the essence of university knowledge transfer management in the new context will be

creating value through interorganisational connectivity and distribute value among the collaborative stakeholders. Notably, the maximization of transaction value offers a new perspective for the governance of university knowledge transfer system as it emphasizes on interorganisational connectivity rather on the efficiency of an individual organization, and focuses on the dynamic process of value distribution rather the ex ante structure of the value chain (Zajac & Olsen, 1993), for instance, the knowledge transfer success should not be evaluated solely by economic returns but should consider the wider social and economic benefits(Lambert, 2003).

The proposition of transaction value came from the criticism upon the notion of transaction cost. The transaction cost economics theory suggests that transaction costs arise because participants of transaction must safeguard against the hazards of opportunism and assets specificity (Williamson, 1981). In light of this viewpoint, it had been contended that the patterns of value chain governance should be determined by the factor of 'transaction cost' in order to protect the hazards of opportunism. This idea has been challenged by Zajac and Olsen (1993) who argued that participants of transaction should be concerned with maximizing transaction value through value creation initiatives. They criticized the Williamson's 'transaction cost' notion in two areas: 1) standard transaction cost analysis is essentially a single-party analysis of cost minimization; 2) transaction cost theory overemphasizes the structural analysis of interorganizational exchange relationships and neglects process issues. Based on the criticism on the weakness of the conventional 'cost' focussed viewpoints, they also suggested two key elements differentiating transaction value and transaction cost. The first one is that interorganizational strategy should be drawn up based on maximizing joint value, and the second element is the value claim and distribution mechanism should not root on the ex ante structure, but on the process based thinking. Resulting from their analysis, they suggested that when making decisions organizations should (1) know the partner's preferences and concerns as a basis for exchange and mutual gain, and (2) discover ways in which similarities or shared interests can be exploited to maximize co-operative joint gains that accrue to both parties. Additionally, Dyer (1997) also challenged the transaction cost view by study of the US and Japanese automotive business. They argued that transaction cost is not necessarily effective in the decision making for the selection of governance patterns. As for the university knowledge transfer system, the following areas of university knowledge transfer can reflect the advantages of considering the transaction value at policy level:

- The performance measurement: recent research advocate that financial metrics alone are no longer sufficient if universities are to view their third stream activities strategically and contextually (Lambert, 2003; Molas-Gallart et al., 2002). Long-term non-financial performance indicators such as sustained relationships, cultural change and job creation should be introduced alongside the shorter-term more tangible returns such as income, access to resources and expertise and programme delivery.

- The governance: Along with the shift of perspective on university knowledge transfer from transaction cost focused to transaction value focused, the university's approach to the selection of specific patterns of governance should consider the value generated from joint action with stakeholders, exploiting and maximising this value, and also including the common interests of university and stakeholders in setting up the governance of structures and processes, instead of making the decision solely based on the university's preferences and cost based interests. An example of this is since 1990s UK universities have established four major models of knowledge transfer institutions (Library House, 2006), namely the Public Limited Company, the wholly university owned limited company, department within university and the team within a university department. When selecting proper models for knowledge transfer, university decision makers should consider long term returns and preference by knowledge users and government supporting.

- Knowledge transfer units: in the knowledge transfer from university to business, the intermediaries are usually considered as important 'bridge' connecting university knowledge into the business world. The selection of proper intermediaries should consider the joint value which can be created through the knowledge transfer, not the cost. An example is that in the last five years, some small and medium sized research universities in the UK have been signing deals with outside IP commercialisation companies (Library House, 2006). Although the reasons of this initiative may vary in different universities, it is certain that university has started to correct its approach by trying to achieve the overall efficiency (i.e. maximization of the joint value) of the transaction rather than being based on the university's view of transaction cost.

4.2. Towards openness: reflection on the open knowledge transfer

The interviews conducted in the empirical study revealed that the university knowledge transfer community has been greatly attracted and influenced by the concept of open innovation. One of the main results of the Grounded Theory based empirical study is the identification of five 'open' features of university knowledge transfer corresponding to the principles of open innovation. This finding reflects that in terms of knowledge transfer, universities are sharing some organizational characteristics with business, such as the strategy of intellectual property portfolio management, building networks with business and setting up comprehensive performance metrics, which are in line with the evolution of entrepreneurial university. In this situation, the adoption of open innovation in the university knowledge transfer system offers a new perspective for university knowledge transfer stakeholders. For instance, from the open knowledge transfer perspective universities and KTOs should shift their focus of knowledge transfer from legal and technological issues to 'business model' focused as new innovation drivers are continually emerging. In addition, knowledge transfer used to be about assembling and employing the most capable team to cover the extremely broad range of skills required for taking an idea from the research base to market, whereas from the open innovation perspective, the strategy for knowledge transfer is to assemble the right resources, as no matter how big or smart the knowledge transfer team could be, they could never be able to assemble a team that covers all skill-sets needed.

The openness for university knowledge transfer means a seamless integration of knowledge management activities at every step along the knowledge transfer value chain - from spotting a possible market opportunity and research talent, to the development of a supporting distribution mechanism and marketing infrastructure, until the final application of university knowledge. Also the open innovation philosophy for university implies consideration of its capabilities to establish and manage an 'open' community of knowledge, i.e. to serve as a platform for knowledge exchange (Hughes, 2006). In this sense, although the classical value chain model is mostly a closed system, in which the business adds value through internal processes, the university knowledge transfer based value chain model should be much more open to accommodate the new situation of innovation system.

There are a range of interorganizational connections within the university knowledge transfer system, such as spin-out, R&D partnerships, and personal connections. These

connections imply that the university transfer stakeholders could establish and maintain a network, through which stakeholders can create and distribute value. This knowledge transfer network is capable of boosting the internal and external knowledge flow (Arias, 1995; Simard & West, 2006) by fostering problem solving and organizational learning (Powell et al., 1996). As such, the universities should take account of the network characteristics of knowledge transfer and adopt a networking approach. Additionally, open innovation offers a business model focused approach for knowledge management (Chesbrough, 2003b, 2007). In the university knowledge transfer system, the ability to adopt various business models for different sectors, fields and opportunities, as well as for various social value propositions can be critical to boost the knowledge transfer flow. The university knowledge transfer value chain therefore is capable of offering a framework to manage the various business models.

In terms of adoption of open innovation principles, several elements including the strategic intention, engagement in networking, flexibility towards business models and effective IP management are regarded critical enablers of university adopting the open innovation principles in the knowledge exchange with industry. Moreover with respect to the adoption of these principles, some issues that could hamper the adoption of open knowledge transfer principles in universities need to be taken into account.

Firstly some universities or KTOs lack a practical vision on the necessity of a viable business model within university's knowledge transfer missions. The absence of explicit strategy concerning identification and adoption of business models could lead university and KTO to focus on legal, technological and commercial issues, and waste opportunities emerged by new innovation drivers in the new innovation context. Secondly, the protectionist approach to intellectual property management is another issue which needs careful treatment. Open innovation has always emphasized the importance of intellectual property protection as a means of facilitating openness, without losing value. However this should happen in the situation where business models are properly developed or adopted to support the utilization of such intellectual properties. The protectionist approach could significantly reduce the value added from the knowledge transfer activities. Finally the third issue is the adoption of the academic style of governance into knowledge transfer system. This should be attributed to different clock-speeds between university and business, in particular concerning the speed of decision making. If universities are adhering to the traditional academic style

of management in the knowledge transfer activities, the interactions between university and business could be very much constrained.

5. Implications

A number of results of this research are particularly useful for informing practices of university knowledge transfer. Although this research is focused on the management aspects of university KTOs, considering the special role KTOs are playing in the system of university knowledge transfer, this research opens a wider perspective for university knowledge transfer policies and practices.

5.1. Developing a broad perspective

The broad perspective is essential to university knowledge transfer in the context of open innovation. Both universities and KTOs need to embrace a broad perspective in managing knowledge transfer business. Firstly, they should have take account of a wider range of business models and management techniques. As university knowledge transfer is changing towards the more entrepreneurial activities, simulating new business models and management techniques is plausible in the university knowledge transfer. Secondly, instead of limiting themselves as service providers of knowledge transfer, KTOs can position themselves as institutional entrepreneurs (Jain & George, 2007) to actively participate in the technology commercialization business. Thirdly, KTOs activities should be broadened into the community level rather than limited in ad hoc interactions between university and business.

5.2. Balancing unity and diversity

Balancing the multiple demands of a variety of stakeholders with different interests requires dealing with a great deal of cognitive complexity. Limiting focus on unity can stifle creativity and inclusiveness, on the other hand, too great a focus on diversity can lead to confusion and an inability to focus. The UK government has been long adopting a polycentric approach in promoting university knowledge transfer, which has its advantage to cover wider range of stakeholders and disciplines meanwhile adhere to a unified national strategy. From the university perspective, this balance refers to the adoption of distributed structure and leadership and adherence to the unified strategy, which can promote the internal and external interdisciplinary collaborations and meantime increase the efficiency of decision making.

5.3. Being flexible and adaptable

University knowledge transfer is greatly impacted by environmental elements, such as government policies, business development as well as continual emergence of new innovation drivers. These elements have been changing quickly over time in the context of the development of knowledge economy, globalization, and advance of new technologies. Universities and KTOs are facing great uncertainties and opportunities arising from the changing environment elements as well as the complexities and dynamics pertained to the university knowledge transfer system. In this situation, this research suggested that universities and KTOs should be adaptable and flexible to novel business models, new performance metrics, and new IP strategies. Being adaptable and flexible leaves room for creativity, and lessens the impact of complexity and dynamics therefore reducing the difficulties in management.

5.4. Taking knowledge transfer as a social process

In the era of 'open knowledge transfer', new opportunities not only emerge from university's internal research, but are likely to arise from inter-organisational and cross disciplinary collaborations. In this sense, the university knowledge transfer could be understood as a social process. In this situation, both university and business should be proactive in building and maintaining relationships with external stakeholders and encourage the internal and external knowledge exchange. The knowledge exchange communities are therefore showing considerable value to assist universities to assemble talent and resources from external professional communities. As for KTOs, they need to broaden their mission in simultaneously organising and controlling their own communities and interacting with others.

6. Limitations

While this study filled the void in literature regarding KTO management to some extent and contributed to the utilization of new research methodology in the research of university knowledge transfer, it is not without its limitations. The first potential shortcoming of this study exists in the utilization of research methodologies. In terms of the Grounded Theory based research, three issues can be identified as limitation. Firstly, the limitation centred on the representativeness of the participants. This study includes a small number of participants in representing each institution, which limits the

generalisability of research results. Moreover, most participants of this study belonged to a single cohort, which may cause participant bias of the research. As a result, their experiences are likely to be significantly different from other groups of knowledge transfer practitioners in universities.

In addition, in both Grounded Theory study and the Q methodology based study, saturation is always considered as the main limitation of study. Although Strauss and Corbin (1990) have given a definition of saturation in doing qualitative study, saturation is not easy to achieve and also very subjective. In the Q methodology based study, another limitation needs to be considered, that is, the limitation of the Q sample. In the study, participants were limited to describe their own experiences through provided statements. This ultimately limited participants' freedom in expressing their own experiences completely and in their own words. Although using structural method of statements design and 6 times replication were considered as exhaustive, they may not exclusively capture the perceptions by participants.

The second potential shortcoming of this research centred on the theoretical aspect of the research. Firstly, this study was intentionally designed to understand the breadth of the phenomenon which aims to depict the emerging landscape of the development of KTO management. As a result, the specific research elements such as the strategy, process, people and platform may lack in-depth analysis of these issues. Secondly, the objective of the study is stated to be the 'management' of KTO, however the notion of management is too broad and complex to be analyzed simply. Albeit this study resorted to the value chain as the research framework, some other key management issues may still be involved. In addition, this research utilized the value chain paradigm as the research framework, however the interconnections between elements were not the main focus of this study, hence this study may have not provided the most exhaustive perspective of the managerial elements proposed.

7. Future research

As is often expected in an academic research, particularly when exploring new grounds, this research has identified more new ideas and fresh questions than it answers. Some of these ideas are listed as follows.

- Longitudinal study. The university knowledge transfer situation is changing rapidly,

especially in the context of global financial crisis government policy, universities' funding structure, and business' strategies towards this crisis have been changing dramatically. It therefore could be valuable to conduct a longitudinal study to compare the situations revealed in different times. By observing the changes that take place over time, the longitudinal studies would be able to explicitly map the relationship between university knowledge transfer management and the environmental elements.

- Empirical study of governance. This thesis introduced the notion of governance to facilitate a better understanding of the knowledge transfer system. Nevertheless understanding of practical mechanisms of governance is limited, especially in the context that the university knowledge transfer system is in a state of continual change. The empirical study of governance should cover issues of the positions of stakeholders in the system of knowledge transfer and how they interact with each other.

- In-depth study of each management element suggested in this study. This study proposed a general picture of the management, however with respect to each element such as strategy process, people, and platform, the extant literature remains limited. For instance, in terms of the process of knowledge transfer, although the stage-gate process has been identified, few researches have considered the optimization of this process, in particular from the process reengineering perspective.

- Quantitative study. This study suggested key elements of KTO management and identified major concerns of practitioners. Utilizing the quantitative methodology can explicitly identify the relationships between those elements and concerns. This could be complementary to this research by revealing the correlations between these management elements and characteristics of KTOs such as age and size, or the correlation between KTOs' effectiveness and the suggested managerial elements.

- Study of the subject across other economies especially the EU and USA. Also considering the globalisation of innovation and emergence of new players in this game such as BRIC countries, and international focus on the issues to enrich the data and achieve new insights is another important subject for future study.

8. Summary

This chapter summarized the results of the entire research, and more importantly extended the findings of this research to a broader perspective. Main findings of this research including the systematic thinking and open knowledge transfer have been reviewed. Grounded on the results and findings of the research, some issues like governance, transaction value, and open knowledge transfer were further discussed to enhance the results of this research. In addition, the implications for practice and policy making were analyzed. Finally, shortcomings of this research were discussed from both methodological and theoretical perspectives, which were followed by the suggestions of future research.

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APPENDICES

Appendix 1: Consent Form for Interview

Consent Form for Interview

■ OUTLINE

This study is being conducted by Weisheng Liu, Doctoral Research Student at the University of Liverpool Management School, and supervised by Dr. Hossein Sharifi. You are invited to be in a research study of management of university knowledge transfer offices. You were selected as a possible participant because you have rich experience working as leading practitioners in university knowledge transfer office. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

■ PROCEDURES (IF YOU AGREE TO PARTICIPATE)

1. You will be asked to participate in a 1-2 hours interview that will be audio taped, which will be used to review the summary of that interview in written format to verify the primary conclusions made by the researcher or make changes as appropriate.
2. You will also be asked to participate in either a short follow-up interview or email exchange to review summary conclusions.
3. These activities will be carried out between March 2008 and May 2008.

■ RISKS AND BENEFIT

1. Risks: the study has no known risks by an investment of your time to participate in the study interview. (1-2 hours for interview and potentially email to clarify details).
2. Benefits: There are no significant benefits for participating in the interview part of the study, other than providing information that may help to reveal the general landscape of management of university knowledge transfer office. The resulting report of the study will be sent to participant on request.

■ CONFIDENTIALITY

The identities of all study participants will be kept in the strictest confidence. Any report that will be published will not include information making it possible to identify an individual subject. Research records will be stored in a locked, private location and only the researcher will have access to the records. All tape recordings will similarly be kept in a secured location to which only the researcher has access. These recordings will be kept only for academic research purposes and used only with the express written consent of participants prior to such use. A participant number, rather than a name will identify all data gathered and used throughout the analysis.

■ VOLUNTARY NATURE OF THE STUDY

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Liverpool Management School. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

■ CONTACTS AND QUESTIONS

The researcher conducting this study is Weisheng Liu. You may ask any questions you have now. If you have questions later, you are encouraged to contact me at the University of Liverpool Management School, 01517953011, or Weisheng.liu@liv.ac.uk. You may also contact Dr Hossein Sharifi, my PhD supervisor at 01517953622 or h.sharifi@liv.ac.uk

■ STATEMENT OF CONSENT

These details will be reviewed and you will be asked to grant verbal consent at the beginning of the taped interview.

Interview Questions

SECTION I. PROFILE

■ About you	
1) Name	
2) Position	
3) Years in knowledge transfer practice	

■ About KTO	
4) Name	
5) Location	
6) Year of Establishment	
7) Year of Restructure(if applicable)	
8) Number of Staff	
9) Personnel Structure	
10) Organisational structure *(if possible, please supply a copy of organizational chats)*	

Section II Interview Questions

1)	Can you describe your KTO's mission, responsibilities and strategic objectives?
2)	How do you think KTO's mission, and strategic objectives correspond to university's knowledge transfer strategies?
3)	What do you consider to be the major impacts of the operations of KTOs? Please list FOUR most important in the order of importance
4)	Can you explain how your KTO contributes in encouraging and facilitating connectivity with R&D activities with other departments of university or with other universities that may be relevant to achieving viable commercial exploitation? Can you give some examples?

5) Please indicate the entities you consider as KTOs' stakeholders and rank the importance to KTOs

6) Please describe the relationships and main channels of interactions with main stakeholders mentioned above

7) Please explain your understanding of the knowledge transfer process and what roles KTOs are playing in this process.

8) Can you rank the importance of knowledge transfer channels adopted by your KTO?

9) Does your KTO adopt or follow any core 'Business Models' in achieving the goals of knowledge transfer? If so, can you briefly describe them?

10) Is it possible to involve other forms of intermediaries (e.g. technology brokers, specialist agents) in conjunction with the KTO model? If so, what other parallel or alternative models have been considered by your KTO?

11) How does your KTO allocate financial resources among different knowledge transfer activities?

12) What kind of information technologies are used in your KTO to facilitate knowledge transfer, mainly in supporting communication and networking?

13) How do you perceive the role IP is playing in knowledge transfer?

14) How do you understand the relationship between senior staffs and followers

15) How do you describe the roles of senior staff are playing in KTOs

16) What kind of personnel skills are believed essential to achieve the goal of facilitating knowledge transfer?

17) How does the organizational structure impact the communication efficiency of knowledge transfer? Can you describe the typical process of knowledge transfer decision making?

18) What are the performance indicators of KTOs? Are they fit for KTOs? Do you have any suggestions for the development of performance indicators?

19) Barriers and impediments: please indicate the factors and the way and the extent to which they act as constraints to your mission of knowledge transfer.

■ Support (e.g. Funding):	
■ Organisational (e.g. structure, administration, staffing)	
■ Relationships	
■ Policy and strategy (e.g. government and university,)	
■ Process (e.g. clarity, inefficiency, alignment)	
■ Others	

*** ***

Thank you very much for your time and thoughtful comments

Do you have any questions before we complete the interview?

Appendix 3: Cluster of universities knowledge transfer performance

■ Outline

For the purpose of selecting samples for the multiple-case study, cluster analysis was employed on the basis of five university knowledge transfer performance indicators as set by HEBCI annual survey. These are income from contract research, income from providing facilities, income from consultancy, and revenue from active spin out companies as well as the income from IP. All data were collected from HEBCI survey 2007-2008. Importantly, in order to eliminate the bias caused by the value of incomes, the income figures were standardized to the value range from 0.2 to 1.0.

The applied cluster analysis was of the hierarchical cluster approach, which adopts Ward's partitioning technique and Squared Euclidean Distance methods. **Figure I** and **Table A** illustrate the distribution of the clusters based on the five performance indicators mentioned above. After the cluster analysis, the one-way AVOVA was also adopted to test the clusters for being different from each other in terms of the indicators used. **Table B** shows the results of the ANOVA, which confirms the difference between the clusters.

■ Results

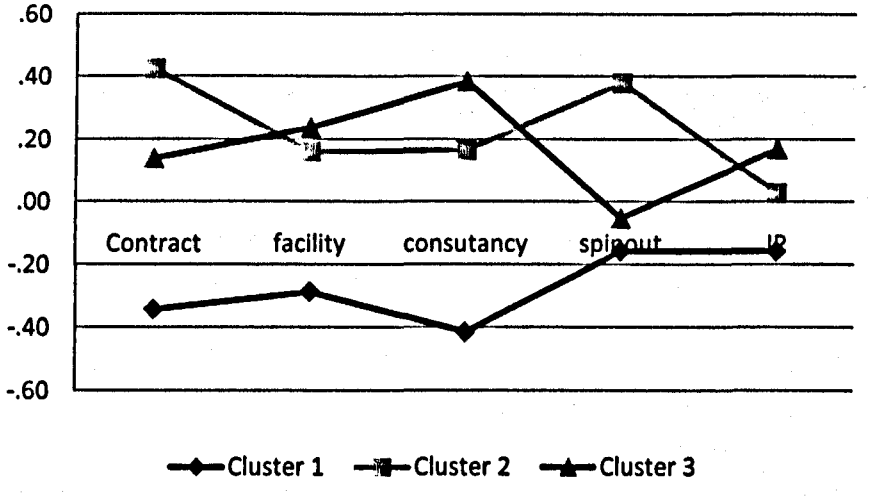

Figure I Cluster of performance of knowledge transfer activities

Table A. Cluster Distribution

		N	% of Combined	% of Total
Cluster	1	67	41.9%	41.9%
	2	36	22.5%	22.5%
	3	57	35.6%	35.6%
Total		160		100.0%

Table B. ANOVA of the cluster results

		Df	Mean Square	F	Sig.
contract research	Between Groups	2	7.712	8.434	.000
	Within Groups	157	.914		
	Total	159			
facilities and Equipment	Between Groups	2	4.822	5.068	.007
	Within Groups	157	.951		
	Total	159			
consultancy	Between Groups	2	10.465	11.900	.000
	Within Groups	157	.879		
	Total	159			
spinout	Between Groups	2	3.504	3.619	.029
	Within Groups	157	.968		
	Total	159			
IP	Between Groups	2	1.674	1.689	.048
	Within Groups	157	.991		
	Total	159			

P<0.05 is regarded acceptable

Appendix 4: Q survey Letter

Weisheng Liu
University of Liverpool Management School
Chatham Street, Liverpool, UK
L69 7ZH
Tel: +0044 (0)1517953011
Email: Weisheng.liu@liv.ac.uk

2nd January 2008
Dear Sir/Madam,

My name is Weisheng Liu and I am currently a doctoral research student studying with Dr. Hossein Sharifi and Prof. Dennis F Kehoe at the University of Liverpool Management School. I would like to invite you participate in a research project to study the UK based university Knowledge Transfer Offices (KTO) with the purpose of boosting the university to industry knowledge transfer system. (This research project is part of the AIM *Innovation and Productivity Grand Challenge* programme)

Enclosed within this letter are 48 cards that record the certain statements regarding KTO management issues. I would very much appreciate it if you could look over the statements on the cards and complete the survey by following the instructions as attached. It should not take you more than 20 minutes to complete (should you indeed choose to do so). I will guarantee that your responses will be held in the strictest of *confidence*. The final reports, in which all participants will remain anonymous, will only contain a summary of the data collected.

The results of this project will be an in-depth thinking of KTO strategic and operations management issues. Through your participation I hope to understand the main issues concerning the KTO management, in particular based on the paradigm of open innovation and mechanism of value chain governance. I hope that the results of the survey will be useful for both KTO practitioners and stakeholders alike. Regardless of whether you choose to participate, please let me know if you would like a summary of my findings. To receive a summary, please contact me through the address above.

Thank you for taking the time to provide me with this important information. If you have any questions, or concerns about completing the survey or about being in this study please don't hesitate to contact me. Again, many thanks for your kind assistance.

Best regards

Yours faithfully

Weisheng Liu
Doctoral Research Student
University of Liverpool Management School

Appendix 5: Instructions to Q sort

Instructions to the survey

These instructions will guide you through this survey step by step. Please read each step to the end before you start carrying it out.

1. Take the deck of cards [see attachment] and the score sheet and go sit at a table. Lay down the score sheet [see attachment] in front of you. All cards in the deck contain a statement about KTO issues. We will ask you to rank-order these statements from your own point of view. Our question to you is:

2. This study is about KTO management. We are interested in your attitude towards management issues of KTO and university knowledge transfer.

3. Please read the attached statements carefully and split them up into three piles: a pile for statements you tend to disagree with, a pile for cards you tend to agree with, and a pile for cards you either agree or disagree with, or that are not relevant or applicable to you. Please use the three boxes "AGREE", "NEUTRAL OR NOT RELEVANT" and "DISAGREE" at the bottom of the score sheet. Just to be clear, we are interested in your point of view. Therefore, there are no right or wrong answers. When you have finished laying down the cards in the three boxes on the score sheet, count the number of cards in each pile and write down this number in the corresponding box. Please check whether the numbers you entered in the three boxes add up to 48.

4. Take the cards from the "AGREE" pile and read them again. Select the two statements you most agree with and place them in the two last boxes on the right of the score sheet, below the "9" (it does no matter which one goes on top or below). Next, from the remaining cards in the deck, select the three statements you most agree with and place them in the three boxes below the "8". Follow this procedure for all cards from the "AGREE" pile.

5. Now take the cards from the "DISAGREE" pile and read them again. Just like before, select the two statements you most disagree with and place them in the two last boxes on the left of the score sheet, below the "1". Follow this procedure for all cards from the "DISAGREE" pile.

6. Finally, take the remaining cards and read them again. Arrange the cards in the remaining open boxes of the score sheet.

7. When you have placed all cards on the score sheet, please go over your distribution once more and shift cards if you want to.

8. Please explain why you agree most with the statements you have placed below the '4':

9. Please explain why you disagree most with the statements you have placed below the '-4':

10. When you are finished, please write down the number of the cards in the boxes you placed them on.

Appendix 6: Profile Data Sheet

PROFILE DATA SHEET

I will be very much appreciated if you could provide some data regarding yourself and the KTO you are working in, which will be used for the data analysis. All the data you provide will be in strict confidentiality. Please send this sheet to me along with the Q-Sort score sheet using the provided prepaid envelop. Many thanks for your time and ideas.

■ **ABOUT YOURSELF**

Your Name	
Your Position in the KTO	
Year in current Position	
Your Background	□Academic □Business □Hybrid

■ **ABOUT THE KTO YOU WORK IN**

Name of the KTO	
The KTO is:	☐ A department in university ☐ A company wholly owned by university ☐ A company partly owned by university
Year of Establishment	
Year of Most Recent Restructure of the KTO (if applicable)	
Number of Staff	
Main Knowledge transfer Activities by the KTO (please give FOUR)	① ② ③ ④
Main Disciplines of Technologies Transferred (please give FOUR)	① ② ③ ④

Appendix 7: Profile of Participants

Profile of Participants

No	Position	Background	Year of KTO Establishment	Year of KTO Restructure	Number of Staff
1	Director Research & Enterprise	Hybrid	2004	2007	19
2	Head of Knowledge transfer Office	Business	2003	-	3
3	Head of Business Development	Business	-	-	-
4	Head of Research and Business	Business	1999	2004	21
5	Business Development Manager	Business	-	-	-
6	Commercialization Officer	Hybrid	1997	-	24
7	Knowledge transfer Officer	Business	-	-	10
8	Licensing Executive	Academic	1998	2006	10
9	Research Development Manager	Academic	-	2007	17
10	Head of Finance & Operations	Business	1997	-	70
11	Contacts & Operations Manager	Hybrid	1986	2008	12
12	Director	Business	2000	2005	10
13	Chairman of the board	Business	1990	-	70
14	Director	Hybrid	2004	2008	20
15	Director	Business	1999	-	30
16	Director of Exploitation & Commercialization	Business	1997	-	19
17	Director	Academic	2002	2005	29
18	Director	Hybrid	2003	2005	62
19	Director	Business	1988	2004	39
20	Managing Director	Hybrid	1994	-	70
21	Business Manager	Academic	1988	2004	39
22	Director	Hybrid	-	2007	65
23	KTP Centre Manager	Hybrid	1999	2008	14
24	Business Development Manager	Hybrid	2000	2003	12
25	Director	Business	-	-	26
26	Knowledge transfer Practitioner	Business	1964	-	32
27	Head of Consultancy & Industrial Research	Business	2000	2008	15
28	Deputy Director	Hybrid	1990	2005	48
29	Deputy Director	Business	1990	2006	57
30	Pro-Vice Chancellor	Hybrid	1997	2007	-
31	Consultancy Manager	Business	1974	2008	2

Appendix 8: Q-sorting of Factors

Q sorts of factor 1

				42				
				47				
				13				
			43	25	18			
		45	44	24	35	3		
		40	29	20	11	12		
	30	34	39	23	1	6	4	
	33	48	26	22	9	17	2	
38	37	41	32	21	14	16	19	5
46	36	31	27	28	8	15	10	7
-4	*-3*	*-2*	*-1*	*0*	*1*	*2*	*3*	*4*

Q sorts of factor 2

				35				
				6				
				39				
			32	8	21			
		38	37	24	22	42		
		30	47	5	16	7		
	41	26	23	2	20	17	9	
	33	36	28	11	18	10	44	
31	27	34	46	15	43	3	1	13
45	40	48	29	19	25	14	4	12
-4	-3	-2	-1	0	1	2	3	4

Q sorts of factor 3

				39				
				22				
				37				
			48	1	34			
		27	45	15	47	10		
		26	30	6	16	21		
	40	42	29	14	31	4	7	
	41	9	46	17	2	18	3	
43	24	36	44	20	11	12	13	19
33	38	28	23	5	8	25	35	32
-4	-3	-2	-1	0	1	2	3	4

Q-sorts for factor 4

				38				
				47				
				20				
			31	27	8			
		33	37	17	23	2		
		1	34	6	16	42		
	40	30	22	28	4	11	13	
	43	39	7	14	5	3	35	
48	26	36	32	15	18	24	19	21
46	45	41	44	9	12	29	25	10
-4	-3	-2	-1	0	1	2	3	4

Appendix 9: Second Round Survey Letter

Weisheng Liu
University of Liverpool Management School,
Chatham Building, Chatham Street, Liverpool,
L69 7ZH

Email: Weisheng.liu@liv.ac.uk
Tel: 01517953011

Dear Sir or Madam,

Hope you are very well.

My name is Weisheng Liu and I am a Doctoral Research Student at the University of Liverpool Management School. At present I am working in the ESRC/EPSRC research programme of Innovation and Productivity Grand Challenge (IPGC).

As you may noticed I have recently sent you a Q methodology based survey seeking your views on management issues pertaining to university knowledge transfer office. As of today I am still looking forward to your completed survey answer.

Your name was drawn through a scientific sampling process in which the practitioners in the UK university knowledge transfer offices have the equal opportunities of being selected. Only 205 practitioners in this category have been asked to complete this survey. For the results of this study to truly reflect to views of practitioners, it is essential that every practitioner in the sample could return a completed survey. Therefore, your kind cooperation in completing the survey will be very much appreciated.

In case you did not receive the survey package that I mailed to you earlier, or if it has been misplaced, please drop me an email to **Weisheng.liu@liv.ac.uk** or give me a telephone call at **01517953011,** I will send you another copy as quick as possible.

Your contribution to the success of this study will be greatly appreciated and I am looking forward to hearing from you. Thank you very much

Sincerely yours,

Weisheng

Appendix 10: Q-Sort Sheet

Q-Sort Sheet

KTO [ ]
DATE [ ]
PARCIRIPANT'S NAME [ ]