THE EMPIRICAL ANALYSIS ON FACTORS THAT IMPACT ON LEVELS OF INNOVATION AND THE DEVELOPMENT OF A REGIONAL INNOVATION SYSTEM

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A thesis submitted in total fulfilment
of the requirement for the degree of
Masters in Business Studies

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June 2012

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LIST OF ABBREVIATIONS

ARE	Applied Research Enhancement Programme
BMW	Border Midlands and Western Region
CAP	Common Agricultural Policy
CSO	Central Statistics Office
EPP	Enterprise Platform Programme
ERIS	European Regional Innovation Survey
GDA	Greater Dublin Area
HEA	Higher Education Authority
HPSU	High Potential Start Up Company
HRB	Health Research Board
IOTs	Institutes of Technologies
IWAK	Ireland West Airport Knock
LQ	Location Quotient
MAN	Metropolitan Area Network
NDP	National Development Plan
NRA	National Roads Authority
NUTS II	Nomenclature of Territorial Units for Statistics (NUTS II)
OECD	Organisation for Economic and Cooperative Development
PRTLI	Programme for Research in Third Level Institutions
REGIS	Regional Innovation Systems Designing for the Future
RIS	Regional Innovation System
RTC	Regional Technical Colleges
S&E	South & East Region
SFI	Science Foundation Ireland
TLIs	Third Level Institutes
TSRI	Technological Sector Research Initiative
TTI	Technology Transfer Initiative
VC	Venture Capitalist
VEC	Vocational Educational Committees
WDC	Western Development Commission

Certificate of Authorship

The author hereby declares that, except where duly acknowledged, this thesis is entirely her own work and has not been submitted for any degree in any other institute

Maria Staunton

2012

ACKNOWLEDGEMENTS

I wish to express my appreciation to my supervisors Dr. Larry Elwood and Mr. Kevin Heffernan for their support and encouragement throughout this process.

I would like to thank Patricia McCann who helped me at the start of this journey.

I would also like to my husband and best friend, Ray, who gave me unconditional support throughout the last four years.

Also my parents, family and friends for their unending love and support especially my mother who made sure that I would finish.

Finally my brother Colm for helping me with the tedious task of editing.

ABSTRACT

The aim of this research is to contribute to a greater understanding of the factors that are conducive and inhibitive to the innovation activity and the development of a regional innovation system (RIS) in a peripheral region such as the BMW region in Ireland. Previous studies have largely concentrated on urban areas. A broad definition of an innovation system is the planned and systemic cooperation in a region that is essential to the development of relationships conducive to the generation and diffusion of knowledge and innovation.

Regions are seen as important bases of economic coordination at the meso-level: 'the region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilising effects of research institutions' (Lundvall and Borrás 1997:39)

Many peripheral areas often have too few firms in the same industrial sector or local production system to constitute a regional cluster, and then an important condition for local networking and interactive learning is missing.

Empirically the study is based on a postal survey which was presented to 96 firms with 45 firms responding (response rate of 47%). From the forty five responses received, eleven companies were excluded (two had ceased to operate, two had incomplete information and seven carried out no innovation or R&D), providing a 36% response rate. In order to further enhance the results obtained the most innovative and least innovative firm were chosen to undergo a further in-depth study (mentioned in more detail in section 2) The combination of the two data-sets enables methodical triangulation which further enhances the results obtained and helps to *'maximise the validity of field efforts'* Denzin (1978).

Eriksson (2000) profiles a complete RIS which looks at aspects such as access to financial capital (VC, grant agencies, banks etc), quality of infrastructure, quality of educational facilities, networks and business associations, as these are all very important elements of a RIS. This research will focus on the top three findings which are Third level institutes, Infrastructure and Financial Capital and will give some recommendations on how policy makers can address these issues in order to develop and grow a strong RIS in the BMW region.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Research conducted on regional innovations systems (RIS') is more often associated with clustered industries in urban regions and knowledge intensive industries (e.g. Silicon Valley, California in the US and Baden-Würrtemburg, Germany) than peripheral or rural regions. In some studies conclusions have been reached that urban areas are more important locations for innovation to occur (Audretsch and Feldmann, 1999). It is much more difficult to find examples of RIS' in peripheral regions. The possible reasons for this are as follows:

1) Urban regions have a high population density and generally a higher concentration of industries. 'Bigger cities…attract more skilled workers, and there is some evidence suggesting that human capital accumulates more quickly in urban areas' (Glaeser and Resseger, 2009)
2) Urban regions are often better equipped in relation to having relevant agencies, educational supports and specialised skill sets, resources and competencies located there (Cooke 2002, Asheim and Gertler 2005).

Another reason could simply be related to the fact that most studies on clusters are based on the analysis of success stories and well-known cases of urbanised regions (Asheim and Isaksen 2002).

This research aims to contribute to a greater understanding of innovation systems in peripheral regions. For the purpose of this research a RIS is defined as: innovation that is

generated and diffused as a result of interaction between various actors (related firms, suppliers, public organisations etc) in the regional environment.

The area chosen for this study is the Border Midlands and Western (BMW) region in Ireland as it is largely a rural and geographically peripheral region with large scale employment in traditional industries. The BMW region is a large and diverse region comprising of thirteen counties, accounting for 47% of the land area of Ireland and 27% of the population (CSO Ireland, 2010). A biomedical cluster has been identified in this region which will be the focus of this research.

The primary objective of the research is as follows:

- To explore the factors influencing innovation activity and therefore the development of an RIS in a peripheral region of an economy'

The primary objective may be specified in terms of the following secondary objectives:

- To develop a profile of a cluster of a RIS operating in a geographically peripheral region including economic contribution to the region and innovation activities
- To identify, specify and analyse the innovation activities of biomedical firms in the BMW region of Ireland
- To investigate and evaluate managers' perceptions in selected biomedical industries on factors which inhibit the development of a RIS in the biomedical sector in the BMW region of Ireland
- To develop recommendations for continued development of a RIS in the biomedical sector in the BMW region of Ireland.

1.2 The Study: Background and Rationale

This section provides a rationale for the study which is bounded geographically to the BMW region in Ireland and conceptually to a RIS. Subsequent to defining the BMW as a peripheral region in Ireland, the concept of a RIS will be explored and a rationale for the research developed.

1.2.1 The BMW Region

The BMW region covers a large and diverse area, comprising of thirteen counties including the six border counties of Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth; the three western counties of Galway, Mayo and Roscommon and the four midland counties of Laois, Offaly, Longford and Westmeath. According to the Central Statistics Office (CSO, 2010), the BMW region had a population of a little over 1.2 million people. It is defined as being a peripheral region in Ireland.

Peripherality can originate from the physical/geographical limitations of a location or a social situation of a region. For example, Spiekermann & Aalbu 2004: 7) define peripheral regions as lacking accessibility to the main markets. The accessibility of a region consists of two functions. The first represents the activities or opportunities to be reached, while the second represents the effort, time, distance or cost needed to reach them (Spiekermann & Neubauer 2002: 7; Spiekermann & Aalbu 2004: 7–8).

In this thesis the area innovation is a main theme and peripherality can impact on innovation be due to lack of resources (materials, human etc) and networks. For example, according to Benneworth and Charles (2005: 539), a region can be defined as peripheral if it lacks the knowledge resources that enable the creation of agglomeration economies and the development of a competitive advantage in knowledge-based activities.

Copus (2001) uses the concept of aspatial peripherality to describe regions which have poor knowledge resources, e.g. lack of infrastructure (physical and technological) with little or poor access to local, national and global institutional structures and networks. Regions defined as aspatially peripheral can face the greatest challenges in innovation activities. They need their own policy measures to enhance their innovation activities and to prevent social and regional polarisation.

The BMW region is a geographically peripheral region, predominately rural, that lags behind the Southern and Eastern Region (S&E) in Ireland. This is shown by a number of key indicators of economic competitiveness, including company start-ups, specifically High Potential Start Ups (HPSU's[1]) and company expansions, productivity levels, inward investment, innovation, intellectual property and research and development (R&D). However despite all this it has a relatively well educated workforce, with a high proportion of young people participating in formal education up to leaving certificate (second level education), and a high number continuing on to third level education (BMW Report, 2005).

Clusters and RIS' are closely related (UNESCAP, 2006:4). A regional cluster can be defined as a group of firms in a similar industry or in related industries that are in close geographical proximity to each other. Clusters and RIS' are closely related as clusters are important sub systems of a RIS. The presence of an industrial cluster is increasingly seen as a key attribute of a region or of a Country's competitive position (UNESCAP, 2006).

A key challenge for the BMW region going forward will be strengthening its economic competitiveness especially in the areas of innovation and knowledge capacity.

1.2.2 Regional Innovation Systems

Asheim and Coenen (2005) summarise a RIS as consisting of a constellation of industrial clusters surrounded by innovation supporting organisations. Doloreux (2004) unpacks this definition further and defines RIS' as a concentration of interacting private and public interests, formal institutions, and other organisations that function according to organisational and institutional arrangement and relationships conducive to the generation, use and dissemination of knowledge. Both these definitions highlight the importance of relationships and supporting infrastructure as key elements of a RIS.

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[1] HPSU - Manufacturing an export focused product or offering an internationally tradable service;
- Based on a technical advantage or a pioneering or innovative idea
- Likely to realise annual sales of €1m and employ 10 or more within three years of start-up; and
- Headquartered or controlled in Ireland.

RIS' have gained popularity as an important economic strategy for policy makers and academic researchers over the last twenty years and many studies have been conducted such as the European Regional Innovation Survey (ERIS) and Regional Innovative Clusters, OECD 2000 (see Table one in appendix A outlining examples of some of these studies). Enright (2001) argues that RIS' are becoming more important because:

- *Increasing levels of international competition due to the globalisation of economies.*
- *Inadequacies in both regional development models and policies.*
- *Economic success resulting from the clustering of firms and industries in many regions worldwide.*

Examples of successful regions with a clustering of firms would include 'Silicon Valley' or the 'Third Italy' where many of these previous studies have been conducted.

1.2.3 Economic Challenges

Many economic issues confront peripheral regions, one of the most pressing being globalisation. Dicken (1998:5) defines globalisation as *'the geographic extension of economic activity across national boundaries...(and) the functional integration of such internationally dispersed activities'*. Globalisation has changed the competitive environment for companies introducing greater challenges but also greater opportunities. While there are many positive aspects such as increased sales arising from demand in a global marketplace, access to advanced technology, variety of styles and tastes etc there are also potential negative aspects such as intensive price, time and quality issues due to cheaper labour and production elsewhere. The rapid development of technology over recent times has changed the ways in which businesses throughout the world operate. The economic prosperity of a nation no longer depends on its ability to produce raw materials but rather on the knowledge capabilities of its citizens and the ways in which businesses harness, sustain and develop these capabilities. Globalisation is reshaping the innovation process worldwide, challenging decision makers in countries, regions and firms (OEDC 2010a). Globalisation is forcing countries to shift their focus away from agriculture and industrial commodities (which in previous times provided enormous

wealth for economies throughout the world) to international services, knowledge and technology which are now perceived as the main drivers of growth. This poses a serious dilemma to peripheral locations such as the BMW region in Ireland as its traditional rural economy is fuelled by these commodities.

In a global economy, Irish firms like so many firms in other countries are presented with new economic challenges. Since 1993, the Irish government has focused on attracting industries through lower corporation tax, promoting access to inexpensive labour; enabling a transformation to occur. Between 1990 and 1995 the economy grew at an annual growth rate of 4.8% (Johnson, Stoskopf, 2009). Between 1995 and 2000 the economy experienced unprecedented rates of growth (averaging 9.5%) in productivity, jobs and living standards leading to high production costs. A shift in traditional industries such as manufacturing to lower cost countries has ensued. Globalisation therefore creates new economic challenges. It can offer opportunities in new markets but also it has the potential to make companies much more vulnerable to external forces.

1.2.4 The Importance of RIS' in Peripheral Regions

As traditional sources of rural economic development (e.g. access to natural resources and relatively lower labour costs) become eroded by globalisation, regions need to reinvent themselves and exploit their own industrial resources and capabilities, creating new businesses and industries. This is essential in order for regions to develop self-reliant economies. Henry and Drabenstott (1996) state that the evidence *'points squarely at rural industry clusters as a major source of growth in rural areas'*. With increasing global competition, regions, particularly those with significant rural and peripheral compositions, face considerable challenges and must consider ways to develop a competitive advantage.

Urban areas are regarded as innovation hubs due to agglomeration economies. Leading universities, business services, as well as headquarters of multinational firms and high-tech intensive industries are often concentrated in metropolitan areas Keeble and Wilkinson, 1999 and Moulaert and Tödtling, 1995).

Examples of these high tech knowledge intensive industries would be found in urban regions such as Silicon Valley in California, Baden Württemberg in Germany and capital regions in Nordic countries. Peripheral and rural regions can be more difficult places to develop innovation systems as there is an absence of sectors with technological complementarities and also a lack of relevant actors in critical mass (Malecki and Oinas 1999). Enterprise in rural areas often tends to be characterised by small firms operating in traditional sectors. Some 65% of enterprises in rural areas in Ireland meet the definition of micro-enterprise i.e. less than 10 employees (NDP 2007 -2013). Smaller companies in Ireland also quite often lack the export focus that larger companies have. According to the CSO (2005), irish medium / large businesses (50+ employees) had a gross output export of €83,169.1 whereas small businesses (3-49) had a gross output export of €1,928.4. Level of exports often influences the level of innovation taking place in a firm, therefore innovation in rural or peripheral regions is often small scale and more incremental than radical (Asheim and Coenen 2005). With international competition intensifying, industries worldwide need to look at innovation especially from a regional context in order to survive and prosper. This will enable regions all over the world to focus and develop their own competitive advantages.

Ireland's National Development Plan (NDP) (2007-2013) has set out to build an economy that can protect itself from the effects of globalisation; no longer reliant on cheap unskilled labour but on intellectual high skilled labour that will fuel growth, thus protecting it from international competition. Ireland's economy, quite simply, will have to forge out its own niche in the market place by developing world-class indigenous industries and a highly educated and skilled workforce producing leading edge technology. Developing a pro-innovation culture supportive of invention, risk-taking and entrepreneurship, investing large sums of money in research and development and fostering effective linkages between academia and industry has been happening. The National Development Plan (NDP) 2007-2013 entitled "Transforming Ireland – A Better Quality Of Life For All" has resulted in the investment of €20 billion in Enterprise, Science and Innovation. Some of this progress has been taking place:

'We are making progress in addressing our well documented economic difficulties. After three years of contraction our economy has returned to growth and we expect that growth to continue. We have trebled our investment in research, development and innovation over the past decade. We also have programmes designed to link enterprise and researchers – in emerging areas such as cloud computing and smart energy grids'. (Speech by the Taoiseach, Mr. Enda Kenny in Sept 2011).

In parallel to this, the regional requirements and competitive advantages must be explored and developed leading to the possible creation of a RIS. Another integral part of the National Development Plan (NDP) 2007-2013 is the development of regions, which recognises the importance of regional development for Ireland. The objective of this plan is to build an economy that can protect itself from the effects of globalisation; achieved by developing high skilled labour that will fuel future growth enabling better protection from international competition.

Indigenous companies in Ireland must create their own niche in the marketplace by developing world-class industries and employing highly educated and skilled workers producing leading edge technology. The NDP stated that by 2010, Ireland will be '*...internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture*' (Strategy for Science Technology and Innovation, 2006-2013:8).

For the purpose of this research the BMW region in Ireland is the region being researched. Policy makers in the Irish Government recognise the importance of innovation and the development of regions in a globalising economy. Strategy for Science, Technology and Innovation, 2006 - 2013 committed an additional €1.88 billion for research. A substantial majority of that funding (81%) is targeted at higher education infrastructure and research and commercialisation in higher educational institutes (HEIs) with the remaining 19% being devoted to enterprise supports (2006:13 & 86).

1.3 Overview of the Research

Biomedical firms in the BMW region have been chosen as the target population for this study due to exhibiting clustering tendencies. Clusters can be identified and 'mapped' by looking at the location quotient based on employment data. Location quotient was developed by Robert Murray Haig in his work on the Regional Plan of New York in 1928. The location quotient is a ratio measure of the concentration of a cluster in a particular location relative to the national average. By a region employing more workers than the national average the industry is producing more goods and services than the region alone can consume; thus the industries export the excess product out of the region. This is detailed further in Chapter Two. A postal survey was administered to 96 firms with 41 firms responding. The firms were then classified into innovation categories. When analysing responses received seven firms were categorised as having no innovation or R&D therefore these seven firms were also excluded from Section One as innovation is a central component for RIS'. In order to further enhance the results obtained the most innovative and least innovative firm were chosen to undergo a further in-depth study. The combination of the two data-sets enables methodical triangulation which further enhances the results obtained and helps to *'maximise the validity of field efforts'* Denzin (1978).

The remainder of this research is structured as follows:

1.4 Summary of subsequent chapters

Chapter One – Introduction

This chapter outlines the research background, the research context and justification and objectives of the research. In addition to presenting an outline of the research the remainder of this chapter presents a summary of the findings of this research.

Chapter Two – Literature Review

This chapter provides a review of the literature. The chapter is divided into three main sections:

- The current challenges of regional prosperity.
- The most important ideas and arguments on RIS'.
- An analyses of the economical structure of the BMW region and the factor conditions underpinning industrial clusters, specifically exploring the biomedical industry.

Finally the literature review is summarised and conclusions are drawn.

Chapter Three – Research Methodology

Subsequent to a brief discussion on ontology and epistemology, this chapter identifies and describes various research paradigms, discussing and justifying the chosen option. It describes the organisation of this research and details the research instrument used to collect the data.

Chapter Four – Research Findings

This chapter discusses, presents and summarises the main findings of this research. It addresses each of the critical success factors in chapter two. Appropriate statistical analysis and content analysis are conducted in order to better understand the information gathered.

Chapter Five – Discussions and Conclusions

This chapter provides an interpretation and discussion of the main research findings. It also highlights the limitations of this study and suggests opportunities for future research.

1.5 Summary & Conclusions

This chapter has provided a background and rationale for this study being undertaken. The primary and secondary research objectives have been defined and an overview of the study has been outlined. The peripheral region being examined in this research is the BMW region in Ireland.

Globalisation of economic activity and the inclination of firms in similar lines of business to locate and operate in close proximity have become a dominant force shaping economic development. All regions especially peripheral and rural regions will therefore be facing considerable challenges in the future and must explore and develop mechanisms for achieving competitive advantages. The economic challenges the BMW region currently faces and possible opportunities to develop competitive advantage have been discussed. Relevant literature in relation to RIS' will be explored next in Chapter Two.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction to the Literature Review

This literature review explores relevant and topical studies undertaken by researchers addressing RIS'. Some of these studies have assisted many local, regional, national governments and international organisations in policy planning (examples include Regional Innovation Systems Designing for the Future (REGIS), Regional Innovative Clusters (OECD), European Regional Innovation Survey (ERIS), more are included in appendix A). This chapter is divided into three sections. Section One will define regional innovation systems and the literature surrounding this. Section Two will examine the challenges that currently exist for regional prosperity and competitive advantages that may be explored in the future. Section Three will analyse the economic structure of the BMW region and the factor conditions underpinning industrial clusters, specifically exploring the biomedical industry.

2.2 Regional Innovation Systems: Defining the concept

2.2.1 Introduction

The concept of RIS' as a policy tool is still relatively new even though it has been researched and discussed since the early 1990s by academics such as Porter (1990), Lundvall (1992), Cooke et al (1996), Wiig (1999), Isaksen (2001), Bathelt (2008) etc. Developing RIS' is viewed as a way for regions to compete internationally as *'specialisation is (...) the only way to overcome the "globalisation trap" that is, outrunning the risk of being outcompeted across the board'* (Lagendijk 2000:165). Regional economies are recognised as *'sites of the most advanced forms of economic development and innovation'* (Scott & Storper, 2003: 580) Edquist & Johnson (1997) and Hodgsen (1998, 1999) suggest that innovation should be an interactive process with

intense communication and collaboration between different actors and other organisations e.g. educational institutes, innovation centres, financial institutions and government agencies etc. This section will present a review of the most prominent literature, defining and differentiating between innovation and innovation systems. An examination of the components of a RIS, focusing specifically on clusters, supporting institutions and various types of RIS' that exist will also be discussed.

2.2.1.1 What is Innovation?

The term "innovation" originates from a Latin verb "innovare", which means "doing something new". Defining innovation is particularly problematic as the term is used in many different applications with similar contexts e.g. innovation is often confused with the term invention and was often previously associated with individuals or companies who created once off inventions. Making sense of innovation is often not an easy task. Innovativeness can be defined as the capacity of an organisation to produce innovations continuously (Galunic and Rodan, 1998) and is considered to entail important organisational outcomes. For example, evidence suggests that the generation of innovations leads to a dominant competitive position (Banbury and Mitchell, 1995; Bates and Flynn, 1995) and that new product innovations serve as a key driver of firm performance (Lee *et al.*, 2003) or help develop competitive advantage (Porter 1990)

Rothwell & Gardiner (1985) suggest that innovation includes small-scale changes in technological know-how (an improvement or incremental innovation), innovation therefore may be viewed as an improved process rather than pure invention. Innovation however must be portrayed as distinct from invention. A scientist in a lab may invent a new product but if that product never reaches the marketplace then it is not an innovation. *'The commercialisation of creativity'* (Simmie and Hart 1999: 447) is something that should be important to all firms. However novel an innovation is, unless firms can exploit or execute their innovation in commercial terms it is not relevant for present purposes. Therefore the willingness of consumers to adapt and use the innovation is the most important aspect of innovation. The commercial value may

depend on the type of innovation that occurs. Maillat (1993) & Jonsson (et al 2000) categorise three forms of innovation:

(i) radical innovations

(ii) major (adaptive) innovations and

(iii) incremental innovations

A radical innovation implies that a totally new product is conceived and developed. Major (adaptive) innovation implies that improvements occur for existing products or new products or processes within a business. Incremental innovations are usually small improvements on existing products and processes. A recent study on 20,000 new product introductions found that while incremental innovation is necessary to retain company value, radical innovations are critical for boosting company value (Sorescu & Spanjol 2009). Companies active in innovation have an average gross value add (GVA) per person of more than €164,000 per annum as compared to €89,000 for non-innovative firms. Furthermore, innovative enterprises are twice as likely to be engaged in exporting (66 percent) as non-innovative enterprises (33 percent).

Porter (1996) identifies innovation as the central issue in economic prosperity. The OECD in its Innovation Strategy 2010 report also recognise its importance. *'Innovation is essential if countries and firms are to recover from the economic downturn and thrive in today's highly competitive and connected global economy'*(OECD, 2010:5). Policy makers worldwide play an integral part in creating and developing innovative economies (e.g. Canada, Sweden, Denmark, Germany, United States, Japan). Ensuring interactivity between the actors in the locality (Gregerson & Johnson, 1996) becomes a crucial part of developing that innovative economy.

Forfás, Ireland's national policy advisory body for enterprise and science, points out in its report 'Making it Happen – Growing Enterprise for Ireland', that innovation is relevant to all firms regardless of size and sector: '*Innovation is a broad concept that is relevant to all aspects of a business,*' it is stated in the report, 'Innovation enables firms to differentiate their product and services offerings, to develop new ways to reach customers and markets, and to improve business and operational processes and organisational structures. Innovation plays a critical role in creating competitive

advantage, enhancing productivity, and ultimately, increasing profitability. It is increasingly crucial for all firms, whether trading in local or international markets, whether large or small and regardless of the sector in which they operate' (2010:xiii)

2.2.1.2 What is an Innovation System?

Gregersen & Johnson (1996) suggest an innovation system can be defined as a system of actors (firms, organisations and government agencies) who interact in ways that affect or influence the innovation performance. Freeman (1987) and Lundvall (1988) were two of the first to promote thinking about systems of innovation, developed as a response to a new economic situation. Decreased economic activity increased the attention and interest paid to innovation in the 1980s. Lundvall (1992:2) defines a system of innovation as being '*...constituted of elements and relationships that interact in the production, diffusion and use of new and economically useful knowledge*'. Knowledge / learning is a key element of this activity. Mytelka (2000) states that linkage and investment are the two other important elements of the innovation systems approach. Innovative activities involve combining knowledge, expertise and investment with good interactivity from multiple and various actors. Innovation and technology development are the results of relationships among actors in the system, which can include enterprises, universities, customers, suppliers and government institutions. However these actors provide no benefit to a firm unless interaction takes place. The possibility of innovation taking place depends on different factors; the number and variety of suppliers, linkages between firms and knowledge institutes and also between firms and industries. Thus it is this collaboration and interaction between suppliers and buyers that leads to new innovations.

2.2.1.3 What is a Regional Innovation System?

A suggested definition for RIS could be - a planned and organised collaboration between firms and supporting organisations within a region, these may include third level institutions, R&D organisations, technology transfer units, business associations, training organisations, financial institutions etc. Planned and organised collaboration is essential in the development of relationships conducive to the generation and diffusion

of knowledge and innovation. The concept of a RIS first appeared in the 1990s and was taken from the concept of national innovation systems (NIS) introduced by Freeman's study (1987) of the Japanese economy. Nelson (1993:4) defines National Innovation Systems as... *'a set of institutions whose interactions determines the innovative performance...of national firms'*. The RIS approach developed when economists felt it easier to manage economic policy at a regional rather than a national scale, as the fundamental components of a RIS are in principle the same as for a NIS. A RIS may therefore be viewed as a local network of actors and supporting institutions whose interactions and activities create, develop and commercialise new technologies. The reason RIS' have become more important is that a national focus can ignore important unique regional competencies. Focusing at a regional level enables policy makers to focus and exploit strengths and resources found within their region. Unique regional competencies embedded in particular patterns of inter-firm networking and inter-personal networks, cannot easily be transferred over space (Asheim & Isaksen, 2002). Recently there has been a growing awareness among regional policy makers that economic development and competitiveness can be developed at a regional level. Regions are seen as important bases of economic coordination at the meso-level: *'the region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilising effects of research institutions'* (Lundvall and Borrás 1997:39). The range and nature of competences devolved from central governments to the regions – both in general terms and as regards matters concerning innovation – is influential in shaping regional innovation policies. Austria, Belgium, Canada, Germany, Spain, Switzerland and the United States are examples of countries where regional policy makers have been granted broad autonomy, which they can use to implement innovation policy at a sub-national level. At the other end of the spectrum, regions in small or centralised countries such as Greece, New Zealand and Portugal are not expected to play as significant a role in innovation promotion in their countries (OECD, 2011).

Figure 2.1 below graphically represents, what Eriksson (2000) called, a 'complete' RIS.

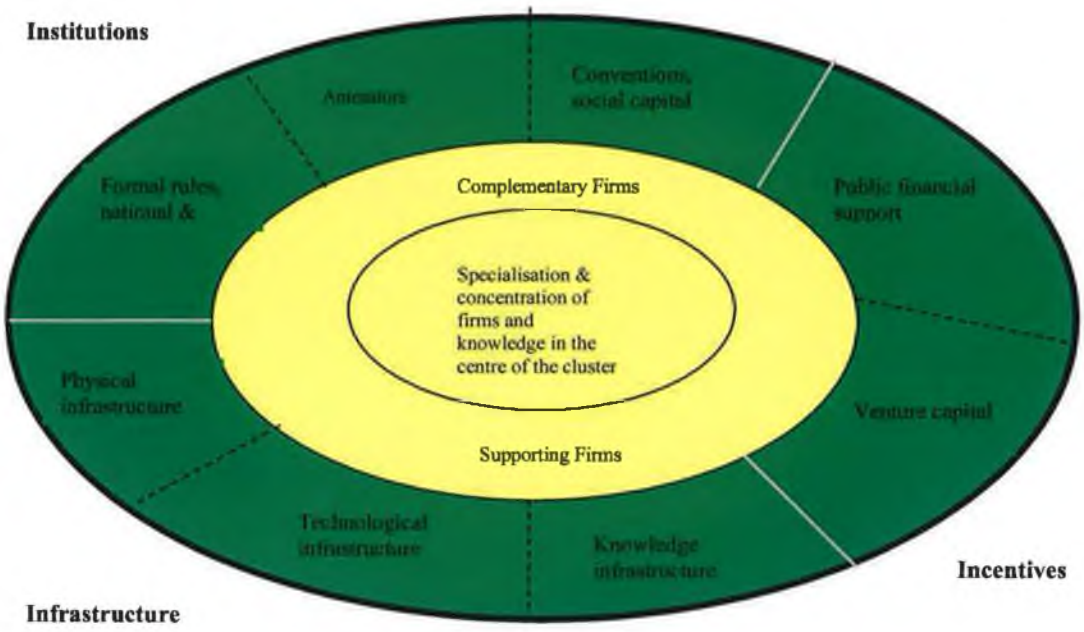

Figure 2.1: *Components of a complete Regional Innovation System, (adapted from Eriksson, 2000)*

Asheim and Isaksen (1997) suggest that a RIS consists of two main types of actors and the interaction that occurs between them. Cooke (2001) suggests that a RIS consist of two sub-systems. The first sub-system consists of the actors which are the businesses or firms in the main industrial cluster in a region surrounded by support industries or complementary firms. The second sub-system consists of the supporting institutions, or the regional support infrastructure which must be present, i.e. research and higher educational institutes, technology transfer agencies, vocational training organisations, business associations, financial institutions etc. These supporting institutions help facilitate, develop and strengthen cooperation and innovation; all important requirements to support regional innovation. They can be informal or formal institutions who influence the way that innovation is structured and processed in the regional environment (North 1990, Hollingsworth 2000). In figure 2.2 above, three elements make up this supporting framework:

- Firstly, an infrastructural system (such as transportation, communication and education) must be in place.

- Secondly, institutions (such as public agencies and regional policy makers) must be present and must facilitate and support private firms' knowledge and innovative activities. They can do this by developing and growing networks, hosting conferences, creating entrepreneurial spirit in a region by celebrating established companies and promoting start-ups and creating operational rules within the region.
- Thirdly, financial resources (such as Venture Capital Companies (VC's), banks, public grants etc) must also be available in the region.

2.2.1.3.1 First sub-system of a RIS - Clusters

2.2.1.3.1.1 Background

The first sub-system consists of those firms involved and participating in an industrial cluster and includes all suppliers and customers to this cluster. Ideally, these firms are linked by horizontal or vertical networking.

There is a large amount of information available worldwide on clustering outlining different strategies and propositions from many renowned writers and researchers on this topic. Some of these writers include Marshall (1920), Piore and Sabel (1984); Porter (1990), Krugman (1991), Cartright (1993),Saxenian (1996), O'Donnell (1997), Feser & Sweeney (1998), Fujita, Krugman and Venables (1999), Bergman and Feser (2001), Batenburg and Rutten (2003), & Porter (2003,2004).

Clustering is seen as a first prerequisite for the emergence of a regional innovation system (Isaksen 2001) and a central component to RIS' as clusters encourage learning and interaction. Clusters can be characterised as a group of companies, their customers and suppliers who draw advantages from their networks and proximity. True clustering occurs when companies of varying size, operating in similar industries are more successful when they collaborate and operate together than when they operate individually. Clusters provide synergies that can lead to competitive advantages, such as access to a skilled labour force, suppliers and support services. Other advantages of clustering are access to innovation, knowledge and know-how. This knowledge or know-how goes beyond the individual firm yet remains within the cluster (Cumbers, Mackinnon & Chapman, 2002). This knowledge is encouraged when firms are located

close to one another, allowing firms to meet frequently and quickly. Clustering also provides industries with a better insight about advances in technologies and change in customer behavior or preference, enabling businesses to focus on what they know and do best. Giblin (2010) states that locating in a cluster is found to be significant for entrepreneurs in three main ways: access to specialised labour pool, quality of life factor that makes it easier to attract and retain labour and the international reputation of Galway as a medical device hub that facilitates entrepreneurs in establishing global networks.

2.2.1.3.1.2 Definition of a cluster

The term 'cluster' has created quite a debate amongst economists and become a lifetime of work for some. Numerous studies such as the software industry in Oslo (Isaken, 2004), the electronic cluster in Toronto (Britton, 2003), the media industry in Montreal (Tremblay et al, 2003), the service industry in London (Keeble et al 2001), the Garment District in New York (Rantisi, 2002) etc have been conducted and various theoretical perspectives have been analysed. However despite this, a common definition of the cluster concept has yet to be found. Feser (1998) contends that despite cluster research, there is no detailed meaning or a clear understanding of their features and how they grow and develop. Porter (1998) described clusters as a geographically proximate group of interconnected companies and associated institutions in a particular sector, linked by commonalities and complementarities. In 2000, Porter broadened this definition by mentioning that these interconnected companies not only cooperate but also compete with one another. A common theme in defining clusters is proximity or location and one which must be explored in relation to regional clustering. Most clusters have a geographic element, often taking the form of an urban agglomeration, which some extend beyond urban areas and regions, sometimes spreading over national boundaries (Niosi, 2000). Although clusters often fit within political boundaries they may cross county, regional or national borders, e.g. in the US a pharmaceutical cluster straddles New Jersey and Pennsylvania near Philadelphia. Similarly a chemicals cluster in Germany crosses over into German

speaking Switzerland. Also a cross-border co-operation between public authorities and the life science industry in the Øresund region (region comprising of southern Sweden and Eastern Denmark) has led to the creation of Medicon Valley, a world-leading biotechnology cluster.

2.2.1.3.1.3 Agglomeration Economies

Economists since the time of Alfred Marshall (1920), who is widely accredited with the first description of industry clusters, sought to explain their complex dynamics and features. He used the term *'industrial district'* and *'agglomeration economies'* to describe British industries during the UK industrial revolution, industries such as the textile industry in Lancashire and Yorkshire, the pottery industry in Stoke on Trent, the cutlery industry in Sheffield and the metal manufacture in Birmingham in his book *Principles of Economics* (1890).

Marshall identified three reasons why groups of firms in a particular industry who located near one another, would be more productive than they would be individually. These are:

- Labour market pooling. A concentration of similar firms would attract, develop and benefit from a pool of labour with common set of skills. Searching for staff maybe easier where the labour pool is large. Training costs for staff and recruiting staff with specific skills to match a company's needs maybe lower due to a larger pool of staff to choose from.
- Specialised suppliers. A concentration of firms leads to a good market for suppliers enabling them to locate in close proximity.
- Knowledge spillovers. Marshall's reference to the intangible dimension of how '*the mysteries of trade become no mysteries as if they were in the air*' (Marshall 1961: 271). This interpretation explores how ideas can move easily from firm to firm as talented or skilled individuals can transfer knowledge from one place to another. Cooperation and competition between firms also leads to mutual exchange of information in turn enabling knowledge and innovation.

Agglomeration economies are often associated with urban economics due to economies of scale. Evans (1985) suggests economies of scale enable production costs to decline and enables potential customers compare on quality and price. Barquero (2001) believes that cities stimulate innovation because they act a hub for innovative activities, exchanging goods, services and know-how. An example of successful agglomeration economies would be shopping cities, as major shops are drawn into the cities and consumers prefer the concentration of shops due to variety and convenience. Agglomeration economies would also normally be associated or known by one major industry e.g. Silicon Valley has become an international renowned cluster for computer and high tech electronics, whereas Harley Street and Saville Row in London are reputed for quality medical and tailoring services respectively (Pandit et al, 2001).

Agglomeration externalities have been recognised by economists as a key cornerstone to clustering. Approximately one hundred years after Marshall introduced his thoughts and work in this area, the theory of industrial district has been extensively revisited [Piore and Sabel (1984), Best (1990) and Krugman (1991)]. It is believed it was revisited due to the worldwide recession in the 1970s and 1980s. The reasons economists began exploring this theory was due to one fundamental question: why do some regions prosper during hard economic times?

2.2.1.3.1.4 Diamond of Competitive Advantage

Porter (1990) examines how clustering and local rivalries encourage innovation and productivity growth in economic development. He questions how some countries have become market leaders in certain areas: Germany in luxury cars and chemicals, Switzerland in pharmaceuticals and chocolates and America in personal computers, software and movies. His theory builds on existing thoughts by proposing that clusters consist of a geographic concentration of competitive firms in related industries who have competitive advantage because they share certain components.

- Firstly participating in a cluster enables firms to operate more productively (better access to technology, sourcing raw materials, accessing information,

customers, markets and employees). The more developed and intense the interactions, the greater the productivity for the firms concerned.

- Secondly it encourages them to innovate as they can more clearly perceive new buyers needs, learn about evolving technology in their field and also experience greater rivalry due to increased competition.
- Thirdly it stimulates new business formation as entrepreneurs located within or near clusters can seek opportunities where gaps exist. New businesses may also establish in cluster locations due to higher economic gains and lower risk.

Porter's theory suggests the competitive advantage of an industry derives from the four different determinants of competitive advantage which are created within the home base of a country. This was portrayed by his 'Diamond of Competitive Advantage' theory. This diamond consists of four elements:

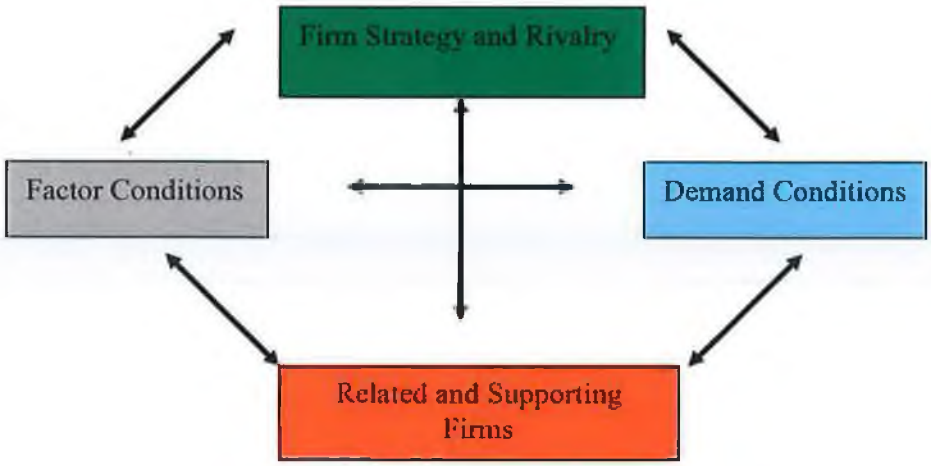

***Figure 2.2**: The Diamond of Competitive Advantage (Porter, 1990)*

The interaction of all these elements (indicated by the arrows) promotes or hinders business success and economic development in any region. In the example shown below, clusters in different counties have been used to highlight these various elements.

- *Factor conditions* – a region's factor endowment. This includes a skilled labour force, specialised infrastructure, natural resources and presence and strength of educational institutes and research establishments. It also includes

taxes, government incentives, wage level, cost of living etc which make it more conducive to success in a given industry.

Example: Japanese skilled workforce (there was a high level of electrical engineers per capita).and sophisticated infrastructure in the fax industry led to Japan's competitive advantage in the fax machine Industry

- *Demand conditions* – the nature of home demand for a given product or service, which can pressurise local firms to innovate faster, stay ahead and enhance productivity.

  Example: The British are known for their gardening and British firms are world class in gardening tools. Italians are known for sophistication about clothes, food and sports cars, all areas of international success.
- *Related and supporting industries* – networks of buyers and suppliers transacting in close proximity to foster active information exchange. Cooperation between firms and their suppliers leads to innovation because these firms must exchange information and knowledge about new processes and products therefore leading to exchange of ideas and innovations.

  Example: In Italy the producers in the leather footwear industry interact regularly with leather manufacturers on new styles and manufacturing techniques. Footwear manufacturers learn about the new textures and colours of leather on the drawing board. Leather manufacturers, in turn, gain early insights into fashion trends which help them plan new products.
- *Firm strategy, structure, and rivalry* – an environment that is conductive to intense competition among local producers. This also helps and encourages other members, making it a strong base for innovation and regional competitive advantage. This forces all members of the cluster to improve their efficiencies, control costs and look for ways to enhance or differentiate their products, by innovating and creating new technologies. Local rivalry provides a strong stimulus to the creation of competitive advantage.

  Example: In Germany, Staedtler the number two manufacturer of pencils in Germany decided to concentrate very early on foreign markets because the

industry leader Faber-Castell dominated the domestic market. Faber-Castell encouraged by Staedtler's success decided to expand internationally also. With little or no domestic rivalry, firms are more often content to rely on the home market (Porter, 1998).

Porter's model is an important framework for examining the sources of an industry's competitive advantage and has contributed in helping to develop cluster studies and economic policies worldwide.

2.2.1.3.1.5 Developing Cluster Policy

Clusters have become an important economic strategy for policy makers worldwide. An increasing number of OECD-countries governments actively pursue cluster based policy as a means to foster regional economic development (Lagendijk 1999, OECD 1999, OECD 2000). Universities worldwide also pursue studies in this area e.g. there are cluster studies prepared by teams of graduate students mostly from Harvard Business School and the Harvard Kennedy School of Government and other universities as part of the requirements for the Microeconomics of Competitiveness course taught by Prof. Michael E. Porter. These studies can be found on the Harvard Business School website. The purpose of these studies has been to understand the emergency of clusters and each study focuses on the competitiveness of a specific cluster in a country or region and includes specific action recommendations. Some examples are listed below in Table 2.1

***Table 2.1**: Examples of Cluster Studies by Harvard Business School*

Name of Study	Year	Authors
The Italian Sports Car Cluster	*2006*	Aaron Bigbee, Francisco Irarrazavan, Felipe Raddatz Adam Ross, Sarma Aparna
UK Competitiveness and the International Financial Services Cluster in London	*2007*	Kirk Allen, Adrian Brown Josh Friedman Sandra Nudelman Patrick O'Brien
The Video Games Cluster in Japan	*2009*	Tetsuya Azuma (HKS) Marten Sziraczki (HBS) Nobutaka Takeo (HKS) Satoshi Yamada (MIT Sloan)
Ireland's Information and Communication Technology Cluster	*2010*	Rene Leon, Wrede Petersmeyer, Vicente Piedrahita, Jules Walter, Dimitri Zaninovich
Israeli Biotechnology Sector	*2006*	Alastair Bell Jessica Freireich Terry Heymann Eric Mboma Tamunumo Alia Zaharudin
The North Carolina Furniture Industry	*2009*	Sandeep Acharya Zach Clayton Sebastian Eriksson Giwa Eyal Malinger Andre Moura

In the US, cluster based activity is found in all fifty states. Some successful ones being Silicon Valley (computer and high-tech electronics), Hollywood (film-making), North Carolina (household furniture), Las Vegas (gambling casinos), northern California (wine) and Boston (biotech and medical instruments). The aforementioned Silicon Valley has become a renowned success worldwide and is now home to one-third of the hundred largest technology firms created in the US since 1965. Other successful examples throughout the world are those such as northern Italy (fashion shoes), London (financial district) India (Bollywood, film-making), southern Chile (wine), southern Germany (high performance automobile), Switzerland and Japan (watches), Helsinki (Mobile telecommunications), Israel (irrigation equipment and advanced agricultural technologies) and Singapore (electronics) etc. Van der Linde (2003) has identified that

more than eight hundred have been documented around the world. Therefore cluster-based economic development has become an increasingly important among national policy makers and academia. Clustering is not however a new phenomenon as it can date back to the textile industries in Twente and Barbant in the Netherlands during the 19th Century (Mokyr 1976). The difference however with clusters today compared to previous cluster formation is the way in which they are occurring. Today, due to policy implementation in some countries, research institutions and businesses are coming together to produce new exciting innovations. Policy implementation includes public subsidies which attracts industry and academia to collaborate and produce new innovations. Some successful well-known clusters throughout the world are concentrations of knowledge based companies located alongside or close to research and educational institutions known as high-technology clusters e.g. biotech cluster around Cambridge in the UK and Munich in Germany. This is particularly the case in the US. During the 1990s, Silicon Valley in California became renowned as an emerging centre of global high-tech development, with tight knit relationships between universities and industries. Other examples are Route 128 in Boston, Austin Texas and North Carolina. Synergies that can occur from clusters are numerous and include:

1. Companies benefitting from being located close to the commercialisation of research and research opportunities.
2. Universities in turn benefitting from funding and commercialisation of research which in turn can lead to higher status being achieved amongst academic circles.
3. Students and graduates benefitting from the opportunity to acquire real life work experiences.

Policy makers in different parts of the world have been seeking to duplicate successful SME clustering experiences to unlock the wealth of their own regions (Asheim, 2001). Policy makers in the Irish government have also been directing national policy towards campus incubation and research facilities. Since 1997, Enterprise Ireland's, through its Campus Incubation Programme, invested €50 million in incubation centres at third-level educational institutions around Ireland. The purpose was to encourage the establishment of high-tech, knowledge-intensive enterprises. A total of €38 million has been invested

in facilities at the Institutes of Technology's, while €12 million has been invested in businesses and more specialised bio-incubation space in the Universities (Drudy 2010).

Replicating successful educational institutes (e.g Trinity, UCD) can be difficult in peripheral regions such as the BMW region in Ireland due to the lack of large scale research institutions and the lower level engagement between industry and academia.
In peripheral regions, innovation activities are frequently at a lower level in comparison to more central and agglomerated regions (European Commission, 2003; Feldman, 1994). The scope of innovations found are small-scale, incremental in nature, and take place mainly through the application of existing knowledge or through new combinations of knowledge (Asheim & Coenen 2005). In peripheral regions, levels of innovation in the private sector, (dominated mainly by small traditional enterprises with little R&D and low absorption capacity), are frequently lower in comparison to metropolitan regions (Tödtling & Trippl, 2005).
Peripheral regions also suffer from low graduate retention rates therefore there is often a lower level of skill capabilities on offer for high tech industries, more specialised qualifications are often rare (OECD, 2010).
According to Cooke et al (2000) peripheral regions often lack specialised services with a mismatch for the demand and supply for innovation. Technology transfer organisations have often been set up in the past in order to improve the situation in peripheral region, however they have been frequently found not to be effective. In many cases they did not reach the companies or they did not meet their demand well enough (Asheim et al, 2003, Lagendijk, 2000).

Peripheral regions must look at how they can develop clusters based on the dominant industries already located there. As stated previously in this chapter good examples of regional policy have identified core industry strengths already present and built on them e.g. designing and manufacturing ski boots has become an important cluster in Montebelluna in Italy. Another example is Western Scotland which was previously dominated by traditional heavy industries in decline. Scottish Enterprise (SE), an Economic Development Agency in Scotland, started to actively pursue Foreign Direct

Investment (FDI) becoming known as 'Silicon Glen'. Soon afterwards it started to look at developing its own indigenous industries in order to have a more sustainable future not solely dependent on FDI investment. SE and Strathclyde European Partnership jointly developed a Regional Integrated Strategy (RIS) and published a Joint Economic Strategy. This been very successful in targeting industries, creating incubators, science parks, innovation development within companies and partnerships with private industries and public bodies. Successful examples in Scotland today can be found in the biotechnology and life sciences, optoelectronics, health care and software industries. Policy makers must also understand that clusters take a certain period of time to develop and often develop due to a chance event. Policy makers must also understand how its best applied to their own region with own set of circumstances and challenges and understand that there are certain conditions for clutering and RIS' as discussed below. Policy makers must understand that not all regions can be successful at creating a Silicon Valley or a Silicon Glen.

2.2.1.3.1.6 Conditions for Clustering and RIS'

Although economists seem to agree on at least the overall idea of clustering, they may disagree on how it's applied to different regions. Some policy makers devote too much time and effort into supporting and developing high-tech clusters, some policy makers try to emulate other regions and the one-size fits all approach doesn't necessarily work. In developing these high tech clusters, policy makers often ignore the question of what conditions are necessary for these types of clusters. Sometimes clusters may end up as 'cathedrals in the desert' (Hassink 1992). Castells and Hall (1994) state that developing high-tech clusters is very difficult due to high costs. One such example is Akademgorodok in Russia. In 1958, Russian leader Khrushchev and his advisors travelled to Silicon Valley in the US. Impressed by what they saw they went back to Siberia to establish a high-tech cluster in a hilly forested country (20 miles south of Novosoibirsk and 2,500 miles east of Moscow) devoted entirely to science. Many scientists and graduates were attracted by the overwhelming sense of intellectual freedom, felt so acutely in the post-Stalinist Soviet Union. Fourteen scientific institutes and the Novosibirsk State University made up the core of the emerging scientific center.

According to Josephson (1997) the planned 'City of Science', however failed to produce another Silicon Valley the Russian President had planned. When the Soviet state under Mikhail Gorbachev collapsed in 1991, the government's support for science ended and many of Akademgorodk's brightest scientists fled as did a system geared toward nourishing young talent. A similar example can be found in Mezzogiorno in the southern part of Italy.

According to Leonardi (1995) the Italian government's ignorance of regional specificities resulted in a construction of industrial complexes that did not fit into the existing structure of southern Italy. Instead of replicating high-tech clusters national policy makers must look at their own strengths, uniqueness and competitive advantages rather than imitating successful clusters in other locations (examples include crafts in Baden Würrtemburg and Emilia Romagna, chocolates in Switzerland and Belgium, music in Nashville etc).

2.2.1.3.2 Second sub-system of a RIS - Supporting Institutions

Regional clusters and RIS' are viewed as places where close cooperation and communication may stimulate innovation and shared knowledge. Therefore Supporting Institutions based in the region are also a vital component in the development of a RIS. A RIS is characterised by collaboration and cooperation in economic activity between firms and knowledge providers such as Universities, Institute of Technologies, Innovation Centres, Science Parks, R&D agencies, Finance Institutions, Business Associations, Training Providers etc. This then develops and evolves over time. Public bodies have an important role to play to support this learning process by offering services and other mechanisms that grow and intensify the inter-linkages between the actors at the core of the RIS. These organisations can develop important know how, train and upskill the labour force, provide finance and investment all which support regional innovation. The main reason for developing policy that supports RIS' is to encourage improvements in performance and capabilities in local firms operating within and outside the region. From this standpoint, Cooke (2001) acknowledges the importance of promoting interactions between different innovative actors such as universities, start-up

firms and established firms who should have good reasons to interact. This interaction leads to knowledge exchange, collaboration and most importantly to innovation.

An important model to mention here is the Triple Helix model devised by Leydesdorff & Etzkowitz, (1998). Figure 2.3 below graphically describes the Triple Helix model. University, industry and government can collaborate (e.g. work together to leverage resources) to create or discover new knowledge, products or services.

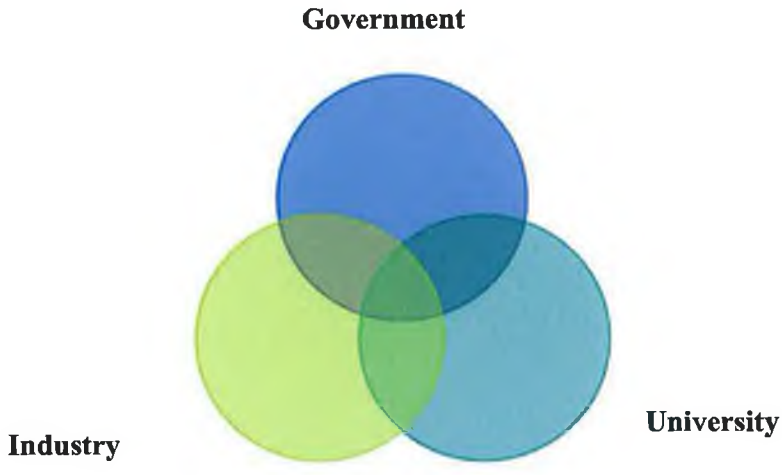

Figure 2.3: *The Triple Helix Model.*
Source: Henry Etzkowitz & Loet Leydesdorff, 2000

Each assumes its own traditional role in society but also takes on another part of the other. Universities for example develop incubation centres and technology transfer officers. Government provide funding towards innovation and research and companies undertake research with academic institutes. Innovation is the result of local interaction between university, industry and government and as a university becomes more dependent upon industry and government, so too do industry and government become more dependent upon a university. According to Cooke (1996), Baden Württemburg in Germany has been proactive and successful in promoting cooperation between State, Industry and Science. Policy makers in the afforementioned region have introduced various state initiatives such as Steinbeis Stiftung. This is an initiative aimed at promoting and facilitating technology transfer from research centres and universities to SMEs. Trinity College in Ireland is such an example. It established its own innovation centre with support funding from the state agency, Enterprise Ireland. The purpose of the centre was to host enterprises, establish industrial laboratories and most of all to help academics become entrepreneurs. Since then many campus companies have been established (e.g. Iona Technologies) and MNCs have been attracted to the research laboratories of the college which also attracts top university researchers. Similar initiatives have since been introduced all over Ireland with other Universities and also Institutes of Technologies.

2.2.2 *Types of Regional Innovation Systems*

Interaction which takes place between third level institutes, industries and government is called the Triple Helix Model. This reflects a top down model of innovation. However a broader conception of the 'innovation system' includes *'all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring'* (Lundvall, 1992:12). This broader definition incorporates the elements of a bottom-up model of innovation, which Asheim (2001) calls 'learning regions'.

It is important to understand that different types of RIS' can exist. To understand this more clearly the generally accepted distinction made by Asheim (2002) will be studied which looks at 'territorially embedded innovation systems', regional networked innovation systems and regionalised national innovation systems. Table 2.2 below outlines the components of these types of RIS'.

***Table 2.2**: Some characteristics of the three main types of regional innovation systems (based on Asheim and Isaksen, 2002)*

Type of RIS	Location of knowledge organization	Knowledge flow	Important stimulus of cooperation
Type I Territorially embedded regional innovation system	Locally, however, few relevant knowledge organisations	Interactive	Geographical, social and cultural proximity
Type II Regional networked innovation system	Locally, a strengthening (the cooperation with) knowledge organisations	Interactive	Planned systemic networking
Type III Regionalised national innovation systems	Many outside the region	More linear	Individuals with the same education and common experience

- Type one is called a territorially embedded regional innovation system. Firms involved in this type of RIS are based mainly on localised learning stimulated by close proximity. They have a lengthy tradition of learning and interacting with one another. They are dependent on locally developed knowledge. These firms have minimal interaction with knowledge providers therefore the probability of these firms producing radical innovations is low and ability to identify new innovations elsewhere may cause issues in the future. A good example of this is Emilia-Romagna in Italy where the productive system is strongly based on SMEs many of which are organised in networks and clusters. Examples of regional clusters in Emilia Romagna are: the mechanical engineering, the motor industry and the textile and footwear cluster.
- The territorial embedded RIS can be further developed into regional networked innovation system moving to the second type of RIS. The basic needs are the same as the first type of RIS, but in this case networking is better planned and more systemic. This is where enterprises are still embedded in a particular regional system of interactions and learning. As Asheim and Gertler (2005:301) point out, '*it is a cluster of enterprises surrounded by supporting agencies and institutions*'. These regions are often the industrial core regions of their perspective countries. Some good examples of this include Baden-Württemberg and North Rhine-Westphalia in Germany and Tampere in Finland There is a stronger more developed role for regionally based R&D institutes, vocational training organisations and other local agencies involved in firms' innovation processes. Firms looking to compete on a national and global scale cannot rely on just localised learning and knowledge they must look outside to other sources of knowledge. Increased co-operation with local R&D institutes may give firms access to information and competence which may enhance local competence thereby increasing collaborative innovative capacity.
- The third type of RIS is a regionalised national innovation system. This is different from the two preceding types in that the institutional networks and

> innovation practices take place with actors outside of the region Asheim, and Gertler (2005: 302). Within such systems, cooperation is most likely to arise between people with the same occupational or educational background (e.g. scientists or engineers). An example of this is the clustering of R&D laboratories of large firms and / or government research institutes in planned *'science parks and technopoles, normally located in close proximity to universities and technical colleges, but, accordingly to evidence, typically having limited linkages to local industry'* (Asheim, 1995). A good example would be the electronics cluster in Horten, Norway.

The purpose of this research is to firstly understand if the factors conducive for innovation activity and the development of a RIS exist in the BMW region. Earlier in this section the issue of not clearly defining a meaning or unified consensus on the dynamics for cluster growth was mentioned which may perhaps lead to an argument that all regions, however defined, have some kind of innovation system?
If this is so and a RIS is clearly defined the question then is which type of RIS is more likely to develop in the BMW region.

Section Three below will undertake an economic analysis of the BMW region, the results should determine whether a cluster exists, which already states is an essential component of a RIS. Chapter Four (Findings Chapter) will then determine if a RIS is currently working within the BMW region and what factors are current perceived as conducive and / or inhibitive for current or future growth of this RIS.

2.3 Regional Innovation Systems: Peripheral and Core Regions

2.3.1 Overview

This section provides a definition of regions in particular defining the BMW region in Ireland. This section also examines and explores current challenges of regional prosperity and ways to achieve competitive advantage.

2.3.2 Defining Regions

Niosi (2000:8) states *'any definition of a regional innovation system should start by defining regions'*. Defining regions can be problematic and a major reason for this difficulty is the variation in regional powers from country to country. The boundaries of regions are not necessarily defined forever. Regions can change over time, new regions can emerge and develop, some can decline and old regions can resurface. The governance of regions can also vary, sometimes spanning more than one government department in different countries. Silicon Valley for example, is situated between San Jose and San Francisco and because the Valley transcends local boundaries, there is no single politico-administrative authority. Another example is the Øresund region in Europe: a trans-border region in Europe joining Copenhagen in Denmark to Malmaö in Sweden highlighting the various forms of governance in regions.

To analyse a region, specific identifying features must be put in place. Storper (1997:170) states possible features may include *'economic activity dependent on resources that are specific to individual places'*. For example, the Ruhr region in Germany is an economic region with a long-established coal and steel industry. Clusters may also be used to define regions. A regional cluster is defined as a group of firms in the same industry that are in close proximity to one another (Enright 2003). Therefore size, related features, economic similarities and industry clusters can all be taken into account when defining a region.

European Union (EU) Regions

This research will apply the EU classification of regions (also known as regionalisation arrangements). From 1989, the whole of Ireland was designated an *Objective One region* (regions that had a per capita Gross Domestic Product (GDP) that was less than 75% of the Community average) up until 1999. For the period 2000-2006, the regionalisation arrangement negotiated by the Irish government designated the country of Ireland into two Nomenclature of Territorial Units for Statistics (NUTS II). This classification system distinguishes regions by a particular kind of association or related feature (mainly economic and social indicators). The purpose of this classification system is to promote economic development and social cohesion within the EU. In the Republic of Ireland, the two regions established were:

(a) the Border, Midland and Western (BMW) Region which qualified for *Objective One* status for Structural Funds for the full period to 2006.

(b) the Southern and Eastern (S&E) Region which qualified for a six-year phasing-out regime for *Objective One* status up to the end of 2005, and for part of the region to 2006.

Figure 2.4 below highlights the boundary make up of the BMW region.

Figure 2.4: *Map highlighting the BMW Region*
Source: BMW Regional Assembly(2007-2013)

The BMW region consists of:

Border: Cavan, Donegal, Leitrim, Louth, Monaghan & Sligo

Midlands: Laois, Longford, Offaly & Westmeath

West: Galway, Mayo & Roscommon.

For the current Structural Funds (2007-2013) the BMW region has not retained its *Objective One* status and therefore is not covered by the Convergence Strand, previously known as *Objective One* status. The BMW region is currently covered by the Competitiveness and Employment Strand which translates to a significant reduction in aid levels, 75% reduction for the period 2007-2013 compared with the period 2000-2006 (BMW Regional Assembly). The objective of this 'strand' is for regions is to develop

innovation, the knowledge economy, sustainable development and accessibility. *'More than 40% of structural funds have been devoted to innovation...clearly demonstrates the pervasive reliance in regional policy making on innovation as an instrument of regional growth: helping technologically leading nations to remain ahead and peripheral regions to catch up'* (OECD 2011).

Despite the financial benefits of these Structural Funds, competitive challenges within the region still remain and these perceived challenges are examined below.

2.3.3 Current issues that challenge Regional Prosperity

There are many economic issues that confront peripheral or rural regions. Some of these being: globalisation, industrial make-up of a region, dependency on indigenous industries and often high levels of outmigration.

Some issues previously highlighted in peripheral regions were:

- the lack of dynamic actors and of support organisations in peripheral regions that are conducive to innovation and technological change in (Asheim et al., 2003; Isaksen, 2001)
- the imbalance in the science and technology system in favour of the public sectors (Landabaso and Reid, 1999)
- the levels of innovation in the private sector, dominated by small industries with little R&D and low absorption capacity (Tödtling and Trippl, 2005)
- the difficulty to increase human capital and attract high-skill jobs due mainly to the lack of agglomerations economics which has an effect on productivity and accumulation of human capital (Alasia et al, 2005)

The sub-section below will discuss some of these issues or challenges specifically examining the BMW region.

2.3.3.1 Globalisation

Globalisation can thus be defined as the intensification of worldwide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa ... Local transformation is as much a part of

globalisation as the lateral extension of social connections across time and space … what happens in a local neighbourhood is likely to be influenced by factors – such as world money and commodity markets – operating at an indefinite distance away from that neighbourhood itself.(Giddens, 1990: 64).

Globalisation diminishes boundaries between countries and even regions, allowing emerging and developing economies to interact more fully with the developed world, and easing mobility of people and ideas through lower communication and transport costs. Globalisation has in some respects made regions more important than nations (i.e. the regionalism approach). '*There are now more than 300 city-regions around the world with populations greater than one million. At least twenty city-regions have populations in excess of ten million. They range from familiar metropolitan agglomerations dominated by a strongly-developed core such as the London region or Mexico City, to more polycentric geographic units as in the cases of the urban networks of the Randstad or Emilia-Romagna'.* Scott, A. J., J. Agnew, et al. (2001). In a globalised world these regions must continue to develop and grow their own unique competitive advantages and must be able to export to other areas.

Thus while globalisation can provide a unique opportunity of development for regions it benefits those regions which are in the most favourable position to participate whilst other economically lagging regions get left behind.

Therefore *globalisation has a dual effect on regions* (OECD 2011: 33). Globalisation offers many opportunities to businesses and people. However globalisation also confronts policy makers with new economic, social, environmental energy, security and competitive challenges. *'The competitiveness of a regional economy depends in part on demand for its exports and on its ability to produce those goods and services at competitive prices'* (OECD 2007:3). Globalisation means that production does not necessarily need to be close to the purchaser or the end-user. Between 1998 and 2004 for example most OECD regions experienced job losses in manufacturing (an average of 20,000 jobs disappeared in each OECD region). Globalisation can be a positive driving force for policy makers to reinvent their regions and nations. Globalisation for example enabled Ireland to position itself as a centre of a globalised economy instead of a peripheral economy. Some of the top US companies export their goods from Ireland

(e.g. Google, Intel, IBM, Pfizer). Over the past decade, consumers all over the world including Irish consumers, have gained even greater access to a vast selection of products from around the world. The benefits accruing from this have been innovative high quality products at affordable prices. This includes all types of commodities such as DVD players, iPods, computers, mobile phones, cosmetics etc.

This has also placed steady downward pressure on the prices of various commodities used to make the consumer products (e.g plastics industry). This trend applies equally to agricultural and industrial commodities, traditional cornerstones of many rural and peripheral communities. Agricultural products such as beef, grain etc often compete more on price and less on specific attributes. As Togerson and Hamerick (1999) state, globalisation forces down the prices of imports, especially imports that substitutes domestic goods. This in turn increases competition and opens up more export channels. Regional policy makers must therefore identify potential sources of competitive advantage. Interest in the potential for technology-led, regional development strategies has also been stimulated by the example of successful regions (e.g. Heidenreich and Krauss, 1998; Yun, 1998), and the quest by regional governments for more effective alternatives to traditional regional policy (e.g. Hassink, 1993).

This poses a serious dilemma for peripheral locations such as the BMW region which is fuelled by traditional industries. Decline of traditional industries and primary manufacturing has been most acute in regional locations, as they do not yet have the capacity to attract the same level of higher technology replacement industries. This was highlighted in the BMW Regional Assembley's *Audit of Innovation in the BMW region (2004)* as well as in the WDC's report *Enterprise & Employment in the Western Region* (2004).

2.3.3.2 Industrial Make-up

According to the Irish National Development Plan (2007-2013) the vitality of small towns and villages and commercial activities have been very dependent on traditional sectors. Below is a synopsis of traditional industries located in the BMW region in particular: agriculture, fishing and forestry, tourism, manufacturing and construction. The BMW region is heavily dependent on all these sectors for employment e.g. 34.3 %

of men in the Region are employed in either agriculture or construction' (BMW Regional Assembly, 2009). Ireland's regional economies with the noTable exception of Dublin and the South West can be described as performing in a low-skills equilibrium' This is where the economy becomes trapped in a vicious circle of low value-added, low skills and no innovation or imperative to move up the value chain (BMW Regional Assembly 2009). Policy makers must now look at diversifying the industrial base away from traditional industries in search of new innovative opportunities built on technology and knowledge. The capability of a region to generate advanced technology, information and ultimately knowledge is regarded as the *'single most important force driving the secular process of economic growth'* (Breshnahan and Trajtenberg 1995:1).

2.3.3.2.1 Agriculture, Fishing & Forestry

Since the 1960s and 1970s, traditional industries such as agriculture, fishing and forestry were major employers in rural Ireland and although diminishing they still remain major employers. Towns and villages grew up around these industries and people depended heavily on them. In the first quarter of 2000, there were an estimated 133,800 persons employed in agriculture, forestry and fishing, representing 8.1% of total employment in Ireland. By 2010 the respective numbers employed in the natural resources sector was 85,000 or 4.6% of total employment (National Development Plan 2007-2013). Despite these current downward trends, traditional industries still continue to play a major role in the Irish rural economy with 32,200 (6.8%) people employed in traditional industries in the BMW region in 2010. A similar story is evident throughout the EU where Agriculture and Forestry represent 77% (47% and 30% respectively) of land use and approx 5.4% of total employment. In the EU over 56% of the population (covering 92% of the territory) in the 27 Member States live in rural areas. Farming and Forestry remain crucial for land use. The strengthening of the EU rural development policy is therefore an overall EU priority going forward (European Commission Rural Development Policy 2007-2013).

2.3.3.2.2 Manufacturing

Since the 1980s manufacturing has been another prominent industry associated with rural Ireland. This sector has played a critical role in the development of the Irish economy over the past two decades, making significant contributions to employment growth, productivity, innovation, technological change and prosperity. Between 2000 and 2005 manufacturing employment fell by 13% or 31,000 jobs. This followed a 30 year period in which Ireland counteracted the international trend by actually growing manufacturing employment. Sectors such as medical devices (+79%) and chemicals (+27%) have seen a growth in employment since 1995, while textiles (-74%) and electrical and machinery (-28%) have fallen (Forfas Report 2006). These latter industries are quite prevalent in peripheral regions. Today manufacturing is facing an equally challenging future as it encounters a decline in demand for its goods and demand that remains faces competition from cheaper imports (Torgerson & Hamrick 1999). Manufacturing industries in Ireland must look at ways of transforming from being resourced driven to knowledge driven, thereby delivering products of higher value.

2.3.3.2.3 Construction

The general expansion of the construction industry in recent years in Ireland has provided employment for people living in rural and peripheral areas. Employment in the construction industry grew by 28% between 2000 & 2004 in the BMW region, compared with a growth of 22% in the S&E, highlighting the importance of the construction industry to the BMW region (Enterprise Strategy Group, 2004). However since 2008, the construction industry in Ireland has suffered a major economic downturn. This sector has seriously declined within the BMW region encountering major employment losses. *At the peak of the building boom in 2007, one in four in the Western Region worked in construction, a higher share than in the rest of the state. Since then a third of the region's construction workforce (916,400) have lost their jobs' (Western Development Commission 2009).* Construction sector employment has reduced from 57,000 in Q1 2004 to 36,300 in Q3 2010 (36.3% reduction)

The ongoing changes in these three traditional sectors require that attention and investment be focused on the challenges and opportunities that currently face rural communities.

2.3.3.3 Dependency on Indigenous Industries

Dependency on indigenous industries is also a challenge rural and peripheral regions encounter. It can be more difficult to attract multinational corporations to peripheral regions due to issues such as infrastructural deficits, smaller labour pool and a lower skilled labour force due to types of industries already located there. Policy makers in peripheral areas therefore have had to focus more on developing and growing indigenous industries, often much smaller industries. A small business is defined as a business with less than fifty employees (CSO 2008). There are approximately 250,000 small businesses in Ireland, of which approximately 60,000 (24%) are in the BMW Region (Small Business Forum, 2006). Smaller businesses tend to focus on home or local markets, which may prohibit innovation as these businesses become too focused on local markets thereby competing in a much more limited way. However that is not to say that peripheral / rural regions cannot develop and capitalise on these indigenous industries. There are successful examples of regions worldwide, predominantly focused on developing indigenous industries thereby specialising in specific industries. The Basque region in Spain, for example, concentrates on high volume standardised production to world class OEMs (original equipment manufacturer) such as the automobile industry.

2.3.3.4 Outmigration

Peripheral regions can also suffer significantly from large scale outmigration as young well-educated individuals tend to emigrate in pursuit of higher education or employment reasons, to areas offering greater opportunities. This in turn can erode the regions population and future lifeblood. With fewer high skilled workers available it can become difficult to attract new companies to such regions. It also creates difficulties for existing companies in finding new or additional skilled workers to fuel expansion and growth. Regional policy makers must also increase the attractiveness of the region e.g.

developing the leisure and cultural infrastructure. The attractiveness of a region can help to retain young people and attract people from outside these regions to live there. Counteracting these challenges and exploring competitive advantage is something that regional policy makers will have to investigate and this is discussed below.

2.3.4 Exploring a Competitive Advantage

This section will propose that in order to develop a competitive advantage, regions need to foster entrepreneurship, develop quality of life, invest in human capital and invest in the infrastructure of a region such as transportation and communications.

2.3.4.1 Produce more Entrepreneurs

Developing more entrepreneurs can be difficult in peripheral regions due to distance from large markets, relative absence of local competition and the limited market opportunities available (North and Smallbone 2000). If regional policy makers are looking to produce more entrepreneurs, structures and policies must be put in place. These structures include: access to capital, labour, markets etc all vitally important for entrepreneurs. Another important structure to consider is developing networks. Networks enabling the exchange of ideas between individuals and organisations should be encouraged. Such networks would include angel investment networks (informal private investors for start-up companies), research collaboration between universities and start-up companies, business incubators (collaborative environment for start-ups) etc. '*Regions such as Silicon Valley have little trouble retaining entrepreneurs and start-up companies due to the large presence of venture capital (VC) companies'* (Council of Competitiveness 2005:15). Another good example is Castle Goffredo in Italy. The rural co-operative bank have underwritten the hosiery technology centre, funded cluster studies and made loans available to companies (Rosenfeld, 2002:10).

2.3.4.2 Quality of Life

Developing a better quality of life in a region creates a better chance of retaining and attracting individuals to that region. The US National Science Board (2002) suggest that if developing countries provide world-class education and training opportunities, as well

as opportunities for career advancement and employment, the migratory flow could be reduced. Developing a good quality of life includes improving cultural activities, educational opportunities and entertainment facilities all of which help young people nurture and develop strengths. Such improvements can help retain young talent. The provision of education is a significant factor as it can be an important aspect for people when choosing to relocate and also in attracting high skilled management and staff into a region. Meyer and Brown (1999) highlight the importance of higher education as one of the principal conduits of permanent emigration. It is important that policy makers perceive their citizens not only as workers in their community but also consumers, community members etc. Economic and social structures are intertwined and policymakers must remember this. Keeble (1987:20-21) states that '*an increasing number of people running rural-based business are in-migrants who have moved to an areas looking for better work-life balance and enhanced quality of life*'. The cost of living is often a significant factor and a major influencer in relocation. Policy makers must try to take all factors into account when developing the attractiveness of a region.

2.3.4.3 Investment in human capital

Employment opportunities in rural regions can often by quite limited therefore well-educated individuals can be hard to retain. With educational requirements becoming so important in recent years, options decrease for individuals lacking qualifications. Employers would be more likely to import workers from outside the region than to hire unqualified and inexperienced local workers. An example of this is Nokia in Finland who invest in the cultural adaptation and integration of foreign IT workers in order to improve productivity. Innovative companies and High Potential Start-Ups (HPSUs) choose regions that have access to a skilled and educated labour force. High skilled labour is an essential input to an innovative economy. Rural or peripheral regions with no Colleges or Universities must develop alternative ways of accessing education in order to upskill individuals (e.g. e-learning, outreach courses etc). Developing linkages between educational institutes and industries in peripheral regions will create greater advantages to both individuals and companies located there.

2.3.4.4. Investment in Transportation and Communication

The European Commission (2004) states that developing regional competitiveness is highly dependent on a sufficient endowment of physical infrastructure and human capital. The development of infrastructure is very important not only in attracting new industry into a region but retaining companies and individuals in the area. Infrastructural deficits leave rural areas at a disadvantage. High-speed internet access is also of major importance to industries. This can help counteract the remoteness a company can experience by being located in a peripheral area. Growth in the broadband market has been strong in the last few years, with Ireland's broadband population penetration rate increasing to 20 per cent by the end of 2008 compared to 17 per cent in 2007. This places Ireland in line with the EU average but slightly behind other member states such as the UK, France, Belgium, Sweden and Estonia. According to the CSO Quarterly National Household Survey 2008 figures, 53% of the BMW regional households are with an internet connection compared to 65.8% of the population in the South and East. This places the BMW region at a disadvantage to the S&E. Parts of rural and peripheral regions in Ireland may always find it difficult to access broadband due to quality of infrastructure and also Providers may not see the profitability in providing broadband to these remote regions. Therefore national and regional policy makers need to look at this and find solutions. In Northern Ireland, a £1.9 million Broadband Fund was financed under the European Regional Development Fund 'Sustainable Competitiveness Programme 2007-2013. Northern Ireland is to be the first region in the EU to achieve 100% broadband coverage.

2.3.5 Building a Competitive Advantage

By exploring competitive advantages that a region possess, regional policy makers can then look at how best to build or develop these competitive advantages in order to compete globally. Enabling goods / services to survive and prosper in a global marketplace, entrepreneurs must look beyond their own boundaries and even beyond their own country to export markets. However in order to do so, their product / service must be able to stand the test of the global marketplace. Porter & Stern (2001) argue that

building innovative capacity in industries has a strong relationship to a country's overall competitiveness and level of prosperity, as *'innovation has become perhaps the most important source of competitive advantage in advanced economies'* (2001:15). RIS and clusters can play an important role in achieving and developing the competitive advantage for a region.

2.3.6 Critical Success Factors conditions underpinning Industrial Clusters and Regional Innovation Systems

In order to identify the critical questions when designing the questionnaire for primary research, the factors that underpin clusters is of utmost relevance. Gallo and Moehring (2002) state that in order to stimulate cluster creation factors such as geographic proximity of markets and suppliers, a skilled specialised labour force, availability of natural resources, infrastructure and low operational costs are all important requirements. Even though all clusters are different, a number of common features stand out as underpinning the development of high performance clusters throughout the world. In 2004 the Department of Trade and Industry in the UK published 'A Practical Guide to Cluster Development' as an aid to those engaged in the delivery of cluster policy on the ground. These were:

- Presence of functioning networks and partnerships
- Strong innovation base with supporting R&D and partnerships where appropriate
- Existence of a strong skills base

Additional success contributing factors, although not perceived as critical, were also included: an adequate physical infrastructure; the presence of large firms; strong entrepreneurial cluster; and the access to sources of finance (Borrás & Tsagdis 2008).

Common success factors cited in this research are:

- The 'core' elements of cluster formation such as networks and partnerships.
- The 'harder' elements such as regional support infrastructure. This includes physical, technology, and knowledge / educational infrastructure (including innovation and R&D).

- The 'softer or intangible' elements. This includes business support programmes, entrepreneurial culture and the presence of leadership in a region. These factors are also cited by the Innovation System Regional Network (ISRN) established in Canada in 1998 (Thérin 2007).

Core Businesses (Networks & Partnerships)

In reference to figure 2.2 earlier in this chapter (and illustrated in figure 2.5 below) which looked at the components of a complete Regional Innovation System, core businesses are firms that are at the very core or centre of the cluster (highlighted in yellow).

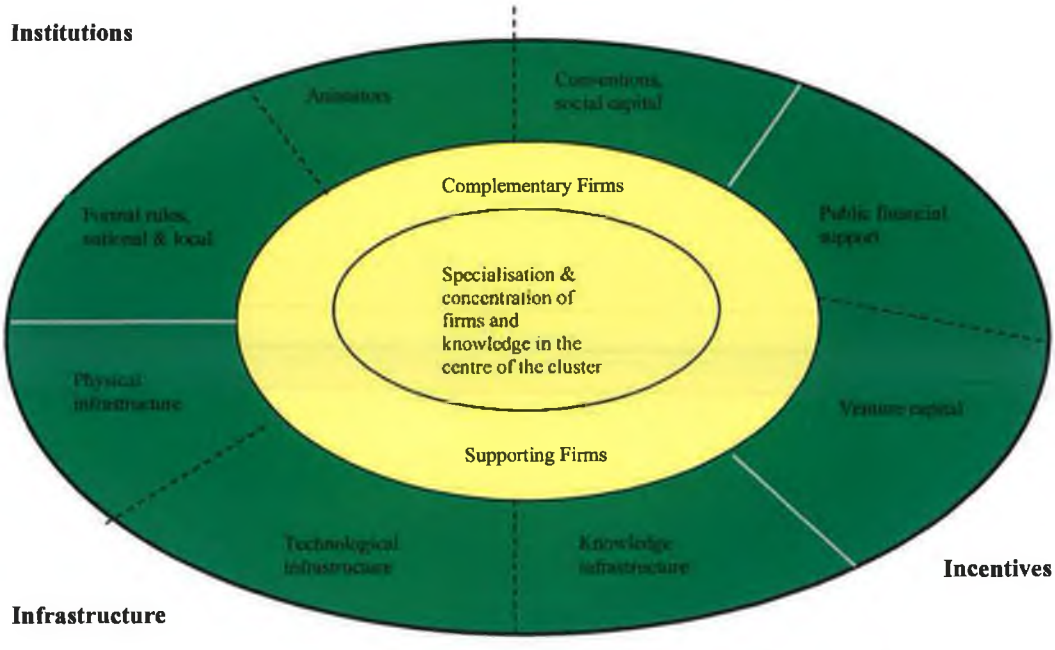

Figure 2.5: *Components of a complete Regional Innovation System, (adapted from Eriksson, 2000)*

The OECD (1996) states that cooperation and collaboration through formal and informal networks is the key engine of growth for many small firms within a cluster. A network provides an opportunity to SMEs for collaboration (Enright, 2000), which has the potential to lead to international business opportunities. Networking is the process that moves and spreads ideas, information, and best practices throughout a cluster and

imports them from other places. Local network relationships could provide useful access to foreign markets and, if leveraged appropriately, lead to joint efforts that are synergistically efficient (Brown and Bell, 2001).

Through networks and partnerships information spreads easily through communication channels such as newsletters, seminars, trade associations, workshops, work / study trips etc. Michael Porter (1990) uses the word 'reputation' to describe a cluster brand image. According to Porter, not only does a cluster improve efficiency and reduce transaction costs but it also creates information and reputation which in turn can be marketed and developed. This in turn attracts more businesses to the region due to the reputational value.

An important factor in the performance of a cluster can be networking and forming quality, trusting relationships. Relationships can be built on common or complementary products, production processes, core technologies, knowledge and skills, natural resources or distribution channels. These linkages can be informal, and may be supported by more formal organisations/institutions. Networks can work well where companies are in close proximity to one another as participants in the local industry already have formed a wide variety of relationships, and there is already some degree of dialogue and trust. According to Batenburg and Rutten (2003), trust established between organisations in regions is one of the most important factors for the successful development of a cluster. The buyer's trust in the supplier's competence is an important element influencing the innovative outcome (Roy et al 2003; Sako, 1992) Forming trusting relationships is therefore a key element of networking and collaboration and because industries in a cluster have long-term relationship, trust is easier to establish. Close relationships take time to build, they are the result of interactive experiences between firms over time.

2.4 Summary and Conclusion

In this chapter the researcher has presented a discussion on Regional Innovation Systems. The researcher has defined innovation, innovation systems and regional innovation systems. The researcher has also explored peripheral and core regions and

how globalisation is impacting on regional economies. Ways in which regions can explore and develop competitive advantages has also been discussed.
The challenge within this literature review is the need to explore the factors influencing innovation activity and therefore the development of an RIS in a peripheral region of an economy. This will be the main focus of study in this thesis.

The next chapter describes and justifies the research orientation and methods chosen to carry out the research.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The aim of this chapter is to develop a research methodology with the potential to address the research question. Such a methodology is based on the follow criteria:

- It must have the potential to achieve the research objectives; identify, specify, analyse and evaluate manager's perceptions on factors conducive to the innovation activity and the development of a RIS in the BMW region.
- It must be consistent with the researcher's positioning with regard to the broad spectrum of research idioms; the researcher's beliefs on what constitute valid knowledge and how knowledge can be generated and evaluated.
- It must be consistent with ethical standards set down by the Galway Mayo Institute of Technology.

The chapter proceeds as follows:

1. The aims and objectives of the research are presented.
2. The philosophical assumptions underlying research are discussed and the stance of the research is specified.
3. Subsequent to a discussion on the most prominent research paradigms, an approach to addressing the research objectives, consistent with the underlying philosophical assumptions is determined and presented.
4. A discussion on the range of research tools consistent with the adopted research paradigm is presented. Tools appropriate to this research are selected and the selection justified.
5. The data gathering and data analysis processes are outlined.
6. A discussion on the ethical issues associated with the research is presented.

7. The limitations of the research are discussed
8. A summary of the research methodology adopted is presented and conclusions are drawn.

3.2 Aims & Objectives

The primary objective of the research is as follows:

- To explore the factors influencing innovation activity and therefore the development of an RIS in a peripheral region of an economy'

The primary objective may be specified in terms of the following secondary objectives:

- To develop a profile of a cluster of a RIS operating in a geographically peripheral region including economic contribution to the region and innovation activities
- To identify, specify and analyse the innovation activities of biomedical firms in the BMW region of Ireland.
- To investigate and evaluate managers' perceptions in selected biomedical industries and supporting institutions on factors which inhibit the development of a RIS in the biomedical sector in the BMW region of Ireland.
- To develop recommendations for continued development of a RIS in the biomedical sector in the BMW region of Ireland.

3.3 Underlying Philosophical Assumptions

Research philosophy relates to the development of knowledge and the nature of that knowledge (Saunders et al., 2007: 101). The most important questions to be answered when a researcher is beginning to develop its research methodology are philosophical questions such as what constitutes knowledge? How does one acquire knowledge? When embarking on a master's research various philosophical questions need to be considered. *'The ideological stance taken by a researcher provides a basic set of beliefs and conceptual context that guides the research process. It defines, for the researcher, the*

nature of the world, the research participants place in it and the range of possible relationships to that world' (Creswell, 1998:254).

All research approaches have underlying philosophical assumptions that implicitly impacts and sways aspects of the research process. The researcher has to carefully consider these assumptions before proceeding with the design of inquiry.

Ontological and epistemological assumptions underpin the research strategy and influence the methods the researcher employ to collect the data. A research methodology must be underpinned by ontological and epistemological assumptions consistent with the researcher's view on what constitutes valid knowledge and how such knowledge can be attained (Saunders et al., 2007). The underlying assumptions enable the researcher to define and understand the reason for the study and make an informed decision about the research design. If a researcher does not ponder on philosophical underpinnings 'this may imply that they either find philosophical questions as non-relevant in their research settings, or take their own philosophical position as self-evident and known' (Eriksson & Kovalainen, 2008:11).

Ontology relates to the nature of reality, that is, what things, if any, have existence or whether reality is the product of one's mind (Burrell and Morgan 1979:1).

It involves the philosophy of reality in other words what is reality? A researcher's ontological assumptions influence the designing of research questions and how the research will be conducted. A researcher may adopt different ontological perspectives or ways of viewing reality. The two positions of ontology are often referred to as objectivism and constructivism.

Objectivism states that there is an external reality that exists independently of peoples' own beliefs, in other words there are external factors which are beyond our reach or influence, and people interpret that reality differently from what it may actually be. Objectivism asserts that *'social phenomena confront us as external facts that are beyond our reach or influence'* (Bryman, 2008:19).

Constructivism states that reality is only evident through socially constructed meanings in other words people create their own reality rather than reality being regarded definitive. Constructivism asserts that *'social phenomena and their meanings are*

continually being accomplished by social actors' (Bryman, 2008:19). Researchers learn best by actively constructing their own understanding by interacting with their environment and subjects and therefore gaining an understanding of the features and characteristics.

Objectivists believe that the mind mirrors reality while constructivists maintain that the way in which the world is perceived is a product of the mind (Jonassen, 1991).

It is clear from these two positions, how one's ontological position will affect the manner in which the researcher undertakes the research process.

Ontology is the commencement point in all research and enables the researcher to develop a theoretical framework after which a researcher's epistemological and methodological positions logically follow.

Epistemology relates to the study of the nature of knowledge, that is, *'how is it possible, for us to gain knowledge of the world'* (Hughes and Sharrock 1997:5), it is concerned with the 'nature, validity and limits of enquiry' (Rosenaue 1992:109) in other words how does one know something? Chia (2002) describes epistemology as how and what it is possible to know. Our epistemological assumptions guide us in gaining an understanding of our knowledge and help us to identify our methods of research. If a researcher has certain ontological assumptions, this in turn influences their epistemological choices.

The paradigm associated with the objectivist epistemology is commonly known as positivism. The paradigm associated with the constructivist epistemology is commonly known as interpretivism. Lincoln and Guba (2000) point out the sharp ontological and epistemological contrast between positivist and interpretivist paradigm. Constructivist or intretivists follow a subjective epistemology signifying that the participant and researcher co-create understanding. They also believe that there is no objective reality, rather it is constructed by individual and collective experience.

In summary, ontology involves the philosophy of reality, epistemology looks at how we have come to know that reality whilst methodology identifies the methods used to attain

knowledge of the reality 'the net that contains the researcher's epistemological, ontological, and methodological premises may be termed a paradigm' (Denzin & Lincoln, 2003:33).

3.3.1 Research Paradigms

A research paradigm is a *'basic belief system or worldview that guides the Investigator'* (Guba and Lincoln 1994:105), in other words how knowledge is generated and what constitutes knowledge. The beliefs must be accepted simply on faith (however well argued); there is no way to establish their ultimate truthfulness (Guba and Lincoln 1994). Table 3.1 below summarises three research paradigms: positivism, interpretivism and critical paradigm and distinguishes their key components.

Table 3.1: *Research Paradigms*

Research paradigm	Philosophical stance	Research goals	Research approaches	Methods
Positivist paradigm	Positivism / objectivism (knowledge and meaning exist objectively in the world independent of human concerns, and wait to be discovered)	Measure, test hypotheses, predict and control, explain, generalise, identify cause and effect	Scientific approach, operationalism, observation	Experiment, survey, sample, Randomised controlled trial (RCT)
Interpretive paradigm	Idealism (knowledge and meaning are constructed by people)	Understand, interpret, seek meaning, illuminate	Phenomenology, hermeneutics, narrative inquiry	Interview, participant and non participant observation, case study, textual review
Critical paradigm	Historical realism	Improve, empower, liberate, raise consciousness	Action research, collaborative research, critical hermeneutics	Interview, focus group

Source: Research Paradigms (derived from Higgs, 2001)

3.3.1.1 Positivist Paradigm

The purpose of research in this paradigm is to prove or disprove a hyporesearch. The positivist researcher gathers, observes and quantitatively measures through large scaled surveys or controlled laboratory testing and objectively verifies a theory. This theory is then tested and if supported through validation it becomes an empirical fact. The

primary objective of the research is theory testing. Positivism is accredited to the French Philosopher Auguste Comte (1798-1857) and is generally associated with quantitative research. Positivists claim that qualitative methods complement quantitative methods but only to a minor degree, and that theory generation is a prelude of minor importance to theory verification (Alvesson et al 2000). The researcher using this method adopts the role of an independent observer, remaining distant when conducting the research and not allowing pre-existed ideas influence their objective views. In order to maintain objectivity, distance between the research process, researcher and research subjects has to be maintained and researchers are therefore seen to be neutral observers. The positivist philosophy emphasises objectivity, repeatability and generalisability (Chen & Hirschheim, 2004). Positivist research can answer questions about something that is happening and the statistical chance of it happening in the future e.g. the performance of biomedical industries in the BMW Region over the past number of years. It cannot however determine why something is occurring or may occur in the future.

Hussey (1997) presents two important criticisms of the positivism paradigm:

- Firstly it is impossible to treat people separate from their social context. Some parts of human behaviour cannot be measured using numbers.
- Secondly a highly structured research design imposes certain constraints on the results and may ignore relevant and interesting findings.

Qualitative researchers criticise objectivity and human detachment as a major issue with the positivist paradigm. This criticism led to the formation of a different paradigm based on subjectivity being implemented in the process of scientific enquiry. This paradigm became known as the interpretivism inquiry or the 'anti positivist' paradigm.

3.3.1.2 Interpretivist Paradigm

The interpretivist research paradigm assumes that the world is just as people perceive it to be (Cavana 2001). Therefore the aim of the interpretivist researcher is for the researcher to uncover the socially constructed meaning as it is understood by an individual or group of individuals (Cavana 2001) and to describe it in a way that is meaningful to these individuals (Saunders 2003). Interpretivism is accredited to Austrian Philosopher Alfred Schutz (1899-1959) and is generally associated with qualitative

research. The interpretivist approach is based on exploration and insight, very different to positivism which is based on experiments and mathematical verification of data. This paradigm emphasises that the researcher is conducting research among people rather than objects and therefore meaning is based on human construction. Perfectly valid meanings can vary from person to person and change from one person to another according to different experiences, perceptions and interpretations. Interpretivist researchers seek to understand rather than explain.

Dahlberg et al. (2001) discusses some key interpretivist assumptions.

- Firstly, with reference to individual inerpretations of reality he argues that experiences and interpretations can be very different from one person to another. Not only does the researcher have to interpret the participants comments but a person reading the researchers comments or findings may also interpret in a different way, leading to multiple perceptions.
- Secondly, he argues that the investigator and the research participant are both influenced and changed by the research process. It is therefore impossible to conduct the research process in a totally detached and objective manner. The ontological assumptions are subjective rather than objective.
- Thirdly there can be no impartial interpretations. All findings are affected by values that the researcher brings to the research process.

As the interpretivist paradigm offers subjective opinions and judgements, many positivist researchers may question the overall benefits of this paradigm *'As such, there is no basis on which to judge the validity of their knowledge claims. One person's view of the world, and of the relationship between social phenomena within it, is as good as another's view'* (Marsh & Furlong 2002:27).

3.3.1.3 Critical Theory

Similar to the interpretivist paradigm, critical researchers believe that research is not value free, however they go further than interpretivist researchers in that they actively challenge perceptions and values in order to change the status quo. The critical paradigm was originally associated with the Frankfurt School in the 1920s (Morrow & Brown 1994). Key figures included Max Horkheimer, Theodor Adorno, Walter Benjamin and

Herbert Marcuse. It is sometimes seen as the third paradigm, an alternative to positivism and interpretivism. According to Lincoln and Guba (1998), the critical paradigm is based on seeking to change elements of social order. Critical researchers aim to confront injustices in society and aim to change situations in society by addressing issues such as inequality, injustice or marginalised groups etc. Critical researchers actively challenge interpretations and values in order to bring about change and assume that they are the best people to make that change happen.

3.3.2 Philosophical Position adopted

Positivism was not deemed appropriate for this study as it ignores the social context by treating participants as independent objects, it lends itself to quantifiable observations and statistical research. The human element is omitted. Positivism '*ignores their ability to reflect on problem situations, and act upon this'* (Robson 1993:60). Positivism considers that properties of the externally existing social world should be measured through objective methods without being subjectively attached through sensation, reflection of intuition. (Easterby-Smith et al., 2008)

Even though statistical analysis will be undertaken to help generalise the main characteristics and innovation activities of these selected biomedical firms operating in the BMW region, it will be based on an interpretivist rather than a positivist stance. When dealing with human beings the positivist paradigm has many limitations as humans attribute meaning to themselves and the world in which they live in e.g. in carrying out the quantitative research, manager's will be ticking boxes on how they perceive various aspects of the region (mostly based on their own thoughts and feelings). In addition, qualitative methods will be used to generate a greater understanding of the information received from the two selected biomedical industries and also understand opinions of supporting institutions who also work with this industry in the region.

The critical approach was also not deemed appropriate in this research as the researcher will not be in a position to make policy changes. However the researcher will submit recommendations to various regional policy makers in the hope that some of these ideas may be implemented.

After analysing the above three epistemological positions, the interpretivist approach has been chosen as the most appropriate underlying philosophy for which the research will be based. Saunders et al., (2007) defines interpretivisim as the epistemological position which advocates the necessity to understand differences between humans in their roles as social actors. This study focuses on RIS' and it is experienced by a particular group of people i.e. the managers of biomedical firms and supporting institutions. The interpretive paradigm was used to 'understand the subjective world of human experience' (Cohen & Manion 1994:36) and as such should try to understand the phenomenon under study through the eyes of the subject.

The ontological position that is compatible with interpretivism is one of a relativist. There are multiple realities based on an individual's perception of that reality, in other words managers in selected biomedical industries and supporting institutions will have many different options and views on innovation and the development of an innovation system in the BMW region. The epistemological stance of interpretivism is that there is no access to reality independent of our minds, no external reference by which to compare claims of truth (Smith, 1983). The researcher and the participant are naturally linked so that findings are mutually created within the context of the situation which shapes the inquiry (Guba and Lincoln, 1994; Denzin and Lincoln, 1994). The researcher needs *'...to explore the subjective meaning motivating people's actions in order to be able to understand these'* (Saunders et al 2003:84) by constant engagement in a process of interpretation and reconstruction of reality based on the constructions or perceptions of those interviewed or observed (Flick, 1998).

In order to explore the interpretivist paradigm further, one must look at the four idioms of interpretive research. These four idioms help understand the logic for considering the positioning of this research therefore it is important that each of these interpretative idioms be considered. The most appropriate idiom of interpretive research will be decided upon and subsequently used to guide the data collection.

3.3.3 Idioms of Interpretive Research

After choosing qualitative research as the best way to undertake the research the researcher must understand the four idioms of interpretive research.
Gubrium and Holstein (1997) describe these idioms as:
'Our strategy for understanding the diversity of qualitative research is to treat each variant as an enterprise that develops, and is conducted in, a language or idiom of its own. Accordingly, each idiom represents a distinctive reality, virtually constituting its empirical horizon'. (p. 5)

Gubrium and Holstein (1997) refer to four traditions or idioms in which reality may be described; naturalism, ethnomethodology, emotionalism, and postmodernism.

Naturalism: The naturalist views the subject through the participants eyes. There is a preference to 'get out and observe the field'.
Ethnomethodology: share's naturalisms attention to detail. Ethnomethodologists are interested in how participants provide account of situations.
Emotionalism: the researcher is interested in prolonged 'intimate' contact with research participants and favours the personal biography. It is more concerned with the interior subjective life of the respondent.
Post-modernism: seeks to dismantle the concepts of the 'subject' and the 'field'.

3.3.4 Selection of Interpretive Idiom

The researcher chooses the idiom of naturalism in order to guide research methodology and develop an understanding of managers perceptions in selected biomedical industries and supporting institutions on factors conductive to the innovation activity and the development of a RIS in the BMW region.
As the researcher collects meanings constructed by biomedical managers as they engage with the world they are interpreting to allow the research to make sense of their perceptions. The researcher attempts to understand the phenomena, through assessing

those meaning, this suggests the appropriateness of a naturalistic and interpretive view of ontology and epistemology.

3.4 Research Strategy

> *"...a strategy of enquiry which moves from the underlying philosophical assumptions to research design and data collection."*
> (Myers & Avison, 2002)

The following section presents a discussion on the selection of research methodology appropriate to the study and outlines various research methods that could be deemed suitable for this interpretive study. These methodologies are briefly described and each method will be considered whether suitable or not for this research.

3.4.1 Action Research

Psychologist Kurt Lewin (1890-1947) pioneered action research in the 1940's. Action Research is *'concerned with 'the development of effective action that may contribute to the transformation of organisations and communities toward greater effectiveness and justice'* (Torbert 1991:219). Action research is learning by doing and taking action. It is where a group of individuals identify a problem and draw up a plan to try to resolve it. They then observe and measure how successful their efforts were and if not satisfied by the results, repeat the process again. The term 'action' in action research refers to undertaking the agreed action and observing carefully what happens. *'The researcher is not an independent observer, but a participant, and the process of change becomes the subject of the research'* (Benbasat, et al 1987). The term 'research' in action research means that any changes or agreed actions are based on well-grounded data. Disadvantages would include that this method is time consuming and complex to conduct. The researcher has rejected this method of adoption as this research is not about changing policy but about understanding the issues and challenges of the BMW region. The objective of action research is to for the researcher to identify the problem and then go about solving the problem themselves. Implementing changes in policy would be the

responsibility of the various enterprise agencies established in the region. However at the end of the study the researcher will submit recommendations to various regional policy makers in the hope that some ideas maybe considered.

3.4.2 Ethnography

Adolf Bastian (1826-1905) is known as the founder of ethnography. A popular definition of ethnography is found in Hammersley and Atkinson (1995), which involves the ethnographer participating in people's lives for an extended period of time, observing and collecting data available for the research. According to John Van Maanen (1996), ethnography is conducted by a single observer who lives with and lives similarly to those being studied often for a year or more and the results are told through the eyes of the local people. These observations can be carried out overtly or covertly. With overt participation, respondents may change viewpoints to be perceived in a different light. Covert observation allows researchers to see what people actually do as opposed to what they say they do. Typical ethnographic research employs three kinds of data collection: interviews, observation, and documents. Robson (2002) remarks that ethnography can be difficult, time-consuming and also demanding and ethnographers need to have an ability to keep an open mind. It relies on close personal experience and even possible participation. It can also be expensive and requires a well trained researcher. It also assumes that the researcher is capable of understanding the culture of the group under study which may lead to bias of the data.

According to Hammersley (1990), there are five features which identify research as ethnographic.

- Firstly behaviour is studied in everyday contexts, there are no unnatural or experimental circumstances imposed by the researcher.
- Secondly observation is the primary means of data collection, although various other techniques are also used. Other techniques could include interviewing, video taping, photography etc.
- Thirdly data collection is flexible and unstructured to avoid pre-fixed arrangements that impose categories on what people say and do.
- Fourthly the focus is normally on a single setting or group and is small in scale.

- Fifthly the data is analysed by attributing meaning to human action described.

This form of research methodology would not be feasible for this study due to the time constraints on managers working within the biomedical industry that are participating in the research process. There is also the issue of bias from the researcher's point of view, the researcher must remain objective. As Lindsay (1997:62) summarises quite nicely: *'It has always posed the greatest problems of intersubjectivity'*. As Wainwright (1997) suggests, '*another bias of the observer, the group itself may be influenced by the very presence of the observer, thus altering their normal set of behaviour'*. It may also be difficult to secure repeat access and often the researcher maybe regarded in a suspicious light. The biomedical industry is highly regulated and intellectual property very confidential due to the profitability of patents in this sector.

3.4.3 Grounded Theory

This theory was developed by two American sociologists, Barney Glaser and Anselm Strauss in 1967. Strauss and Corbin, two of the greatest advocated of grounded theory (1990) state that one doesn't start out with a theory and then try to prove it, rather one chooses an area of study and whatever is appropriate and relevant to that study is allowed emerge from the data obtained. Glaser and Strauss developed this theory while researching the experiences of chronically ill patients, as a means of systematically collecting data and being able to offer clear and precise guidelines for the verification and validation of findings. Before this, qualitative data was largely seen as subjective and unscientific thus this theory enabled a way of justifying this method of research through verification. Therefore a method that could track, check and validate the development of theory from a qualitative perspective was deemed both timely and necessary (Goulding 1998).

The major difference between grounded theory and other methods of research is the specific aspect to theory development. When conducting grounded theory there should be a continuous integration or interaction between data collection and analysis. Using this method, the researcher begins by collecting data in the field and lets the theory emerge or emanate from the data. According to Glaser & Strauss (1967) grounded theory investigates the actualities in the real world and analyses the data with no

preconceived hyporesearch. In contrast to quantitative methodology where the researcher is detached from the research process, the researcher in qualitative methodology plays an important and integral role in the data collection. Another difference of grounded theory to other sources of qualitative methodologies is that it maybe based on one or multiple sources of data e.g. interviews, observations, focus groups etc. However most advocators of the grounded theory approach use observation as their main data gathering method.

Content Analysis

The method of coding qualitative data from open-ended questions from research data is called content analysis. This coding paradigm was originally advocated by Strauss (1987) and further refined by Strauss and Corbin (1990). During the analysis of an interview, the researcher will become aware that the interviewee is using specific words of phrases. This process is called coding, which is basically counting the number of times specific themes arise from the data. Coding should be performed with an open mind without preconceived ideas or notions. Glaser and Strauss (1967) stated that *'preconceived ideas should not be forced on the data by looking for evidence to support established ideas'*. Glaser (2001) recommended that researcher's should just analyse the data in front of them and write what they see.

A major disadvantage of grounded theory would include the laborious task of coding as this can take up some time for the researcher. also the aim of grounded theory is to generate or discover a new theory which the researcher was not trying to do. Therefore the researcher has not adopted this research method in this research.

3.4.4 Case Studies

Yin (1994) defines a case study as '*an empirical inquiry that uses multiple sources of evidence to investigate a contemporary phenomenon within its real-life context, in which boundaries between the phenomenon and its context are not clearly evident'*.

A case study is a research strategy which focuses on a particular case (an individual, a group or an organisation). Case studies can be used as a research method to create new knowledge, solving some sort of issue or problem or test a theory with theoretical

be given to the wording and positioning of each question as this ensures that all questions are understood and interpreted correctly as the researcher intended. The questionnaire must relate back to the overall research questions and aims and objectives of the research. Some disadvantages with using survey are:

- Questions must be general enough to be appropriate for all respondents
- The researcher must ensure that a large number of the selected participants reply

This was the preferred option chosen to collect data from strategic business owners in the biomedical firms in the BMW region. This was largely due to large amounts of generic data, time constraints and sample size. It also generated a high response rate form industry and enabled the researcher to carry out a multi method approach to obtain more detailed information form companies in the region. This mixed method approached is explained in more detail below.

3.4.5.1 Mixed Method

Mixed method research combines quantitative and qualitative data. Triangulation is broadly defined by Denzin (1978: 291) as '*the combination of methodologies in the study of the same phenomenon'*. John Mingers (2001) suggests that the research results obtained will be richer and more reliable. Using one method of data collection can give limited results whereas combining research methods can yield better and more interesting results. The reason for using mixed method research is to validate and get more detailed information on the data sought.

Quantitative V's Qualitative

Currently there is a tendency to classify research as quantitative or qualitative. Similar to the paradigms described earlier in this chapter, this is not easy to classify. While the positivism paradigm focuses on quantitative data this does not mean that one cannot quantify qualitative data e.g. a survey of opinions may be analysed by counting the number of responses and quantifying that data.

(i) Quantitative: Quantitative involves numbers and is deductive. This is where a theory is developed and then a research strategy is designed to test the theory. This is done by applying some form of statistical analysis (Malhotra 2007). Quantitative research is

perceived as being objective and unbiased as the researcher is ideally an objective observer (information is inputted directly by the research participant therefore data is not influenced).

(ii) Qualitative: Based on verbal information rather than numerical information. Qualitative research involves data and is inductive, this is where data is collected and a theory develops from that data analysis. Qualitative research can increase the understanding of the research and it perceived as being subjective, therefore is often criticised as being biased. In qualitative the role of the researcher maybe to participate therefore results may be influenced and data interpreted differently than what was intended by the participant. In Miles and Huberman's (1994) Qualitative Data Analysis, quantitative researcher Fred Kerlinger is quoted as saying, '*There's no such thing as qualitative data. Everything is either 1 or 0'* (pg 40*)*. Other researchers would argue the opposite. Many argue that the two research methods work together.

Mixed method is also referred to as triangulation and can be used to double check the results and helps to enhance the quality and credibility of qualitative research (Patton 1990). Combining qualitative research with quantitative research reduces the general assumptions made and improves statistical reliability which is the strength of quantitative research. As Creswell et al notes (2004), it is more than simply collecting both quantitative and qualitative data. The data must be integrated at some stage of the research process.

Denzin (1978) identified four basic types of triangulation:

- *Data triangulation:* Data gathered through several different sampling strategies. This enables the researcher to gather data at different times on a variety of people in various social settings.
- *Investigator triangulation:* Data gathered from various researcher's to gather and interpret data. This helps to decrease the potential of bias. Lincoln and Guba (1985) state that having more than one researcher has the potential to keep the research team honest, which can increase the credibility of findings.
- *Theory triangulation:* the use of more than one theoretical position in interpreting data. It is a process whereby emergent findings are examined in

relation to different perspectives (Lincoln & Guba 1985, Denzin 1978). It provides a broader, deeper analysis of the findings.

- *Methodological triangulation:* the use of more than one method for gathering the data

Methodological triangulation was deemed suitable for this study. Quantitative data will provide the statistical facts and general profile of biomedical companies in the BMW region regarding innovation activity. This will then be combined with qualitative data gathered through interviews with identified managers of biomedical firms and selected agencies and institutes within the BMW region. The qualitative data will help to explore the issues outlined in the quantitative data and give more detailed information on the data provided. This will enable the researcher to gain a better insight into the opinions of private industry and public agencies as often opinions and perceptions are very different.

3.5 Selection of Research Method

The following section presents a discussion on the various forms of research methods and outlines the most appropriate method for this research.

3.5.1 Focus Groups

Powell (1996) defines a focus group as *'a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research'*. The main purpose of a focus group is to understand participants attitudes, beliefs and experiences in a way that would not be feasible if using other methods e.g. one-to-one interviewing, surveys etc. It is often used to deepen understanding and explain statistical data. Often individuals will have certain beliefs and ideas which maybe more likely to be revealed due to the interaction of the group therefore multiple views and emotions are often obtained within a group context.

In contrast to observation, a focus group enables the researcher to gain a large amount of information (personal feelings, perceptions and opinions) in a short period of time. According to Morgan (1998) they can be used on their own or to complement or validate other research methods.

There are some disadvantages to using focus groups:

- Firstly participants may not express individual views due to being part of a wider group. Certain individuals within the group may monopolise the conversation and attempt to impart their views on other participants.
- Secondly focus groups may also discourage some individuals from not trusting others in the group with personal or sensitive information therefore confidentiality can be a major concern.
- Thirdly focus groups can also be hard to control and manage and also difficult to analyse. According to Robson (2002) the researcher needs to have extensive skills and experience in order for the focus group to be effective. In focus groups the researcher becomes a moderator i.e. maintains order and control within the group making sure the group runs effectively.

The researcher has rejected focus groups as a method of adoption for data collection in this research as it would be very difficult to bring the managers of biomedical industries in the BMW region together at the same time and was felt it was not the best way to get personal views aired. It was also felt it was not the best way to get the honest personal opinions of individuals employed by Agency bodies.

3.5.2 Face-to-face Interviews

This requires that the researcher is present during the interview to personally administer the questionnaire to the participant. This enables the researcher to establish rapport with respondents, clarify questions and ambiguous answers. These interviews yield high response rates in survey research. Disadvantages include the time spent on visiting all participants and also this method can be expensive. For the focus of this study this method was used to gather the qualitative information from the two biomedical managers and the selected agencies and institutes in the region. This enabled the researcher to gain more in-depth knowledge on issues outlined in the quantitative research.

3.5.3 Telephone Interview

This requires the researcher to make telephone contact with the participant, administering the questionnaire over the telephone. This enables the researcher to obtain results quickly and relatively cheaply. Disadvantages include the response rate being lower than face-to-face interviews and also the issue of bias as people with no access to phones are automatically not part of the interview process. This method was deemed as not a suitable method for this study due to the amount of questions asked and the survey structure (tick numerous boxes). It would be too difficult to deliver this survey over the telephone.

3.5.4 Web-based Surveys

This is a growing methodology quite similar to postal questionnaires, the difference being that the questionnaire is emailed to the participant. These web-based questionnaires are usually constructed with specialised and easy to use internet survey software. This type of research is often quick, less detailed and easier to format. Disadvantages include some respondents being overlooked or technical problems maybe experienced. Also some surveys may not be deliverable online. This method was deemed as not a suitable method for this study. As the survey was quite long it was believed that many strategic managers would reject this survey as they may initially treat it as junk mail and delete or may also feel it's very long to complete.

3.5.5 Postal Questionnaires

These are self administered questionnaires, which are sent to the sample population via post. This type of questionnaire must be well structured and easy to understand. Information is gathered relatively quick and easy at low cost and in a standardised way.
It can be sent to a large number of people and can save the researcher time and money. People can be more truthful while responding to the questionnaires regarding controversial issues in particular due to the fact that responses are anonymous. Disadvantages include low response rate and those who do respond might not be representative of the originally selected sample. Also those with an interest in the chosen

subject maybe more likely to respond. Anonymity may cause a problem if questions are not clear and are incorrectly completed and misinterpreted. They are also not suitable to investigate complex issues.

Postal questionnaires were chosen as a method for gathering the quantitative data for this research. One of the main reasons for choosing this method was due to the nature of the sample. It was felt that the questionnaire was too long to conduct over the telephone or by e-mail and questions needed some consideration before responding there by discounting face-to-face interviews. Due to confidential data being sought, it was felt that anonymity was important for the sample population. When designing the survey, the main objective was to keep it as simple and short as possible (without impacting on the quality of the answers or information required) in order to obtain a good response rate. It was also very important that firms understood the relevance of the various questions posed.

Table 3.2: *Summary of Data Collection Methods (outlining advantages and disadvantages)*

Criteria	Face-to-face	Telephone	Postal	Web based
Low Cost			√	√
Quick response		√		√
Rapport with respondents	√	√		
Anonymity			√	√
Detailed questions	√			
High response rate	√		√	

Types of Questions

(i) Open ended: This is where participants can express themselves freely. This is effective at exploring topics in more depth. It can provide too much or little information as questions can be time consuming to complete and analyse. The open ended method was chosen as the most suitable way to structure the qualitative surveys.

(ii) Closed: This is where participants answer with a single word or phrase or choose answers from a selection of multiple choice. This is easier and less time consuming to complete and analyse. Answers can be compared relatively easily and the researcher is likely to have a higher response rate.

One disadvantage is that questions posed may 'lead' the respondent to answer in a certain way.

The closed method was chosen as the most suitable way to structure the quantitative survey.

3.6 Action Plan

This following section presents a discussion on the action plan that the researcher undertook.

3.6.1 Sample Selection

Quantitative research will be conducted on the basis of a structured questionnaire of ninety six biomedical firms in the BMW region (see Appendix B for a copy of the questionnaire). Industries employing five or more people will be selected. The questionnaire to be designed for collecting this information is based on an existing paper by Mika Kautonen (2006) who undertook her research paper on '*The Regional Innovation System Bottom-up: A Finnish Perspective*'. The questions from this enabled the researcher to look at the firms themselves and interaction with organisations and agencies. It was decided to also combine questions from '*Measuring Regional Innovation*' which was developed by the Council of Competitiveness in the United States (2005).

The former developed mechanisms for exploring the interaction between firms and supporting organisations and agencies, while the latter developed metrics for the measurement of regional innovation.

3.6.2 Research Instrument

In order to identify types of prominent activities in regions an analytical tool must be implemented. There is a wide variation in these methods in identifying industrial activity in regions. Markusen (1994), in an approach she calls '*studying regions by studying firms*' describes a multistep process, beginning with a screen (location quotients, LQ) to identify candidate industries. A LQ has already been conducted above and the

biomedical industry has been identified as a potential RIS in the BMW region. The total sample for the biomedical industry was formed from information from the Irish Medical Device Association (IMDA), Enterprise Ireland, Industrial Development Authority (IDA) and the Western Development Commission (WDC) who helped identify individual companies within candidate industries and contacting key personnel to interview.

3.6.3 Non response bias

Ninety six firms were identified in the region by sources such as Enterprise Ireland and the IDA. Databases contained information on biomedical companies located in the region. Questions were directed to the Managing Director and or General Manager of biomedical companies within the BMW region and these were then written to by post in July 2009 (see Appendix C for a copy of the letter that was sent to all the selected candidates). Initially after the first posting, thirty two biomedical firms replied, with no extra prompting required. This was identified by matching responses with the database of company names. When some responses needed a follow up survey, specific individuals such as HR managers were identified by supporting institutions and targeted by the researcher. This was all done over three months (July – Sept 2009). Eventually the researcher received forty one responses in total. This equates to a 43% response rate. The response rate of 43% can be regarded as very good and represents the firm population very well. The non response bias of 57% can be attributed to time constraints on managers operating within this sector. It is sometimes very difficult to contact the right person as the industries can be very large. From the forty five responses received, eleven companies were excluded (two had ceased to operate, two had incomplete information and seven carried out no innovation or R&D), providing a 36% response rate. The response rate of 43% can perhaps be attributed to the researcher having good prior contacts within this sector. Individuals in supporting institutions also helped to identify other key individuals when the response was not forth coming. From the data received 39% of respondents were irish owned (16 companies) and 61% of respondents were foreign owned (25 companies). Fifty nine per cent of respondent (24 companies)

had less than 100 employees, whilst 41% of respondent (17 companies) have 100+ employees.

3.6.4 Data Analysis Techniques

The questionnaire looked at different aspects of the company such as

- Background
- Main Competitors and Customers located
- Changes in markets (domestic and international markets)
- Own R&D & R&D Personnel in the Company
- Innovation
- Maintaining Competitive Advantage

The purpose of these questions was to find out whether innovation was taking place and at what level. Respondent companies were then rated according to the scale of innovation undertaken from 2005-2008. The Likert Scale was then applied on data ranging from 1 (not significant) to 5 (very significant). In 1932, Renis Likert invented a measurement method, called the Likert Scales (often called a *rating scale*), used in questionnaires such as attitude surveys. The Likert Scale is an ordered, one-dimensional scale which respondents choose one option that best aligns with their view. Innovation categories were formed for firms who chose 3+. This categorisation has been adapted from Mika Kautonen's study '*The Regional Innovation System Bottom-Up: A Finnish Perspective'*. The firm was then categorised according to the highest score that the firm ticked.

- **Product innovators**: Those firms that have introduced new products (either major or minor product innovation) based on new or existing knowledge (3-5)
- **Process innovators**: Those firms that did not have significant product or service innovations but have introduced innovation to existing products (3-5)

If a firm ticked less than 3 in all categories then they were excluded as innovation is a central component of a RIS.

If a firm ticked 4 for product innovation but 5 for process innovation then that firm was categorised as a Product Innovator. The reason for this is that companies that undertake

product innovation are usually doing some form of process innovation during that time. Companies in both product innovator groups may also have process innovation as is often the case. If a firm is innovating at all they would firstly be most likely to look at existing products and improve them. It is important to note from the research that most product innovators (63%) also implement process innovation. Therefore for the purpose of this study product innovation was firstly taken into account. As stated previously in Chapter Two, **Product Innovators** are viewed as having greater effect by building company value and this can be achieved by increasing employment and potential revenue whereas **Process Innovators** are viewed as preserving company value or increasing productivity.

In a follow up to results obtained, methodological triangulation was carried out with two firms. The researcher did this by identifying the firm as having the highest level of Product Innovation and the identifying the firm as having a lowest level of Process Innovation from the quantitative results.

The **Product Innovator** chosen was the firm that ticked 5 (highest end of the scale) for the product innovation. The researcher then analysed the amount of money spent on R&D and the amount of employees in the company. The company chosen spent the largest amount on R&D (€20million) and employed a large amount of people. It also had 100 people working in its R&D department.

The **Process Innovator** chosen was the firm that ticked 3 (lowest end of innovation scale). The researcher then took into account the amount of money spent on R&D and the amount of employees in the company. The company chosen spent one of the smallest amount of money on R&D (€100k) and employed the lowest amount of people in its R&D department (2 full and 3 part-time staff).

This qualitative information enabled the researcher to understand the differences in perceptions of the region between highly innovative firms undertaking new product innovations and firms undertaking lower processes innovation. This helped to enrich the quantitative results obtained and allowed the researcher to probe into the answers in more detail.

3.6.5 The Interview Process

Qualitative research through in-depth interviews was conducted with two industries (product and process innovators) identified above and with key agencies involved in innovation and R&D within the region The interview methodology involved conducting 10 in-depth interviews which lasted approx. 2 hours with each participant. The interviews were arranged with role-players who are key representatives in the following organisations: Enterprise Ireland, IDA, WDC, NUIG, GMIT, Sligo IOT, Enterprise Equity and the Western Business Angel Partnership (Westbic).All representatives were emailed in order to set up a date for the meeting (see Appendix D for a copy of the email that was sent to all the selected candidates). The culmination of this data will provide insight into the quality of the region's business environment and generate an inventory of regional assets that could be leveraged to help the region grow, and regional liabilities that may represent barriers to growth.

Table 3.3: *Summary of Data Collection Methods (outlining advantages and disadvantages)*

Respondent Number	Representative of.../Role	Interviewed
Respondent 1	State Agency for Regional Economic Policy	22nd July 2009
Respondent 2	Venture Capital Company	24th July 2009
Respondent 3	Third Level Institute	13th July 2009
Respondent 4	State Agency	10th Aug 2009
Respondent 5	State Agency	13th July 2009
Respondent 6	State Agency	5th September 2009
Respondent 7	Product Innovator	February 2010
Respondent 8	Process Innovator	February 2010
Respondent 9	Third Level Institute	March 2010
Respondent 10	Third Level Institute	April 2010

From the quantitative data the researcher was able to identify certain topics of discussion. The interview questions were based on the questions from '*Measuring*

Regional Innovation' which was developed by the Council of Competitiveness in the United States (2005).

The researcher analysed the data continuously while conducting the interviews thereby able to identify repetitive topics and deepen the discussion on such topics in order to generate more knowledge.

A semi-structured approach was followed by preparing an interview schedule with significant questions in an attempt to stimulate the conversation rather than control the flow of it (Lofland & Lofland, 1984). The nature of the interviews was conversational and informal in an attempt to create a comfortable atmosphere.

Questions varied depending on the organisation but included questions such as regional culture and support structures. An interview with a VC company would have focused more on how many companies in the region were funded and what support is like whereas questions with enterprise agencies would focus more on policies that have hindered and helped biomedical companies innovate in the region, various support networks in the region etc. All participants were made aware that no one organisation would be recognised from the research findings

3.6.5.1 Pre-interview preparations

The process of setting up the face-to-face interviews involved sending email invitations to the selected individuals. The researcher is very familiar with many of the supporting institutions involved in the research process therefore setting up an interview meeting with the selected participants was not difficult to do.

See appendix D for an example of an email sent to a supporting institution.

3.6.5.2 Conducting the Interviews

The interviews were conducted at venues and times that suited the respondents. Again the confidentiality issue was explained and the researcher taped eight of the interviews in order to pay full attention to the participant and allow the participant to fully engage in the research process. However for two interviews recording was not an option in which case the researcher took detailed notes.

The questions asked depended on the organisation being interviewed e.g. if it was an enterprise agency questions ranged from why they believed biomedical companies located in the region to what networks they believe worked well in the region, to how supportive the region was perceived. If the question was aimed at a VC companies, questions were more based on what funds were currently available for biomedical companies in the region to what types of companies they had invested in in the region to having links with university and R&D organisations within the region.

All participants were given a good background of the study and outlined the purpose and general project purpose of the study. (see Appendix E for a copy of the questions of the interviews that were conducted with the selected candidates). These questions were taken from the US Council of Competitiveness (2006).

Purpose of the Study:

- To develop a deeper understanding about the Institutions that helped and hindered the BMW region in reaching its present state of development
- To assess how alliances and networks support and promote regional innovation.

Statement of general project purpose

1. To assess the strengths and weaknesses of the regional innovation environment
2. To understand the factors that impact on the levels of innovation and the development of a regional innovation system
3. To develop insights and recommendations for how the region can improve conditions that support innovative firms and people
4. To catalyse action to improve the regional innovation environment

3.6.5.3 Post-interview Actions

The research played back the recorded material after the interview and then transcribed these recording. After transcription, the researcher made an effort not to make assumptions into statements made during the interview process and in some cases had to contact the participant after the interview in order to clarify statements made.

3.6.5.4 Interpreting the Data

No particular software was used for the interpretation of the data. Finding meaning in the data involved identifying themes and grouping data accordingly. An excel spreadsheet was developed and all data was grouped according to categories assigned and the major themes identified. In a follow up to results obtained, methodological triangulation was carried out with two firms. The researcher did this by identifying the firm as having the highest level of Product Innovation and the identifying the firm as having a lowest level of Process Innovation from the quantitative results.

The **Product Innovator** chosen was the firm that ticked 5 (highest end of the scale) for the product innovation. The researcher then analysed the amount of money spent on R&D and the amount of employees in the company. The company chosen spent the largest amount on R&D (€20million) and employed a large amount of people. It also had 100 people working in its R&D department.

The **Process Innovator** chosen was the firm that ticked 3 (lowest end of innovation scale). The researcher then took into account the amount of money spent on R&D and the amount of employees in the company. The company chosen spent one of the smallest amount of money on R&D (€100k) and employed the lowest amount of people in its R&D department (2 full and 3 part-time staff).

3.7 Strategy for Research Bias

Ultimately, the data collected during the research process is used to inform the research findings. If the data is not credible, the implication is that the findings are potentially suspect. According to Kumar (2005), bias is a deliberate attempt to hide what a researcher has found in their study, or to highlight something disproportionately to its true existence.

Accordingly, it is incumbent upon the researcher to validate his/her findings (Sekaran, 2003). It is not at all uncommon for respondents to simply tick of response options without reading or considering them (Sekaran, 2003).

The researcher should schedule interviews at the respondent's convenience and,

further, when distributing questionnaires, should give participants several days to answer. By pursuing this advice, the researcher would, at least, be minimising the chances that the interview be rushed and the questionnaires blindly answered (Hair et al., 2003). These procedures were followed by the researcher undertaking this thesis. The researcher ensured to firstly give respondents plenty of time and notice to respond to the questionnaire and then. When scheduling the interviews the respondents decided on the day and time that was most suitable to them.

The researcher applied several strategies to eliminate non-response bias. These include:

1. **Identification of Companies:** This data was obtained from Enterprise Ireland and the IDA databases. Ninety six biomedical companies in the BMW region were identified. This data was rechecked to ensure that it was correct and there was no omission of companies from the list.

2. **Call back to non-respondents:** Industries that did not respond back to the questionnaire were followed up with a phone call. Specific individuals such as HR managers were identified by supporting institutions and targeted by the researcher. If the person was unobtainable another questionnaire was posted out. This was all done over three months (July – Sept 2009). Individuals in supporting institutions also helped to identify other key individuals when the response was not forth coming

3. **Data Generation:** All questionnaires were analysed and data generated. This was done of four different occasions to ensure the consistency of the end result.

4 **Data Analysis:** According to Mertens and McLaughlin (2004), the assumption is made that the best way for the researcher to obtain this knowledge is to remain objective, which is achieved by 'maintaining a distance from the people under evaluation'. With data analysis this is overcome by following a strict deployment of data. Finding meaning in the data involved identifying themes and grouping

data accordingly. An excel spreadsheet was developed and all data was grouped according to categories assigned and the major themes identified. This was carried out on four different occasions the consistency of the end result.

3.8 Ethical Considerations

This research was conducted with conscious attention to a number of ethical principles. A covering letter was attached to the quest ensuring participants anonymity and confidentiality. Therefore participants were informed that they will not be identified individually and details listed for the purpose of the research will be regarded as highly confidential.

The researcher would know some of the biomedical managers in the region due to existing work. However all managers were written to and informed that any information obtained would be kept confidentially. All questionnaires were kept in a secure cabinet and only the researcher and supervisor had access to them. Participants were also given an explanation of the research and their role in it. At transcription all identifying details were removed and participants were made anonymous. This meant that participants should feel free to express any opinion without fear of being later identified in any way that might be to their disadvantage.

3.9 Summary & Conclusion

This chapter has provided a descriptive analysis of research philosophy assumptions chosen. The research shall be based on the interpretive approach which is based on the ethnomethodologist view and shall adopt a mixed methodological method using postal surveys and face-to-face interviews with selected participants. It is believed that the results obtained from this methodology will allow the researcher to understand inter firm linkages and linkages with different types of support agencies in the region. The perceptions of industry leaders on issues influencing competitiveness and views of how the regional environment impacts on their firm's innovation will be discussed. It will provide insight into the quality of the BMW region's business environment, generate an

inventory of regional assets that could be leveraged to help the region grow, and regional liabilities that may represent barriers to growth. Sometimes government, educational, and non-profit leaders can offer important perspectives on the regional business environment, however due to their own large involvement in policy creation their views can differ from private business owners. It is believed in this research paper that both points of view are very important to obtain. This will enable the researcher to understand the perceived environment from a top down and bottom up viewpoint.

Figure 3.1 below summaries the research approach chosen.

Appropriate Research Plan Chosen

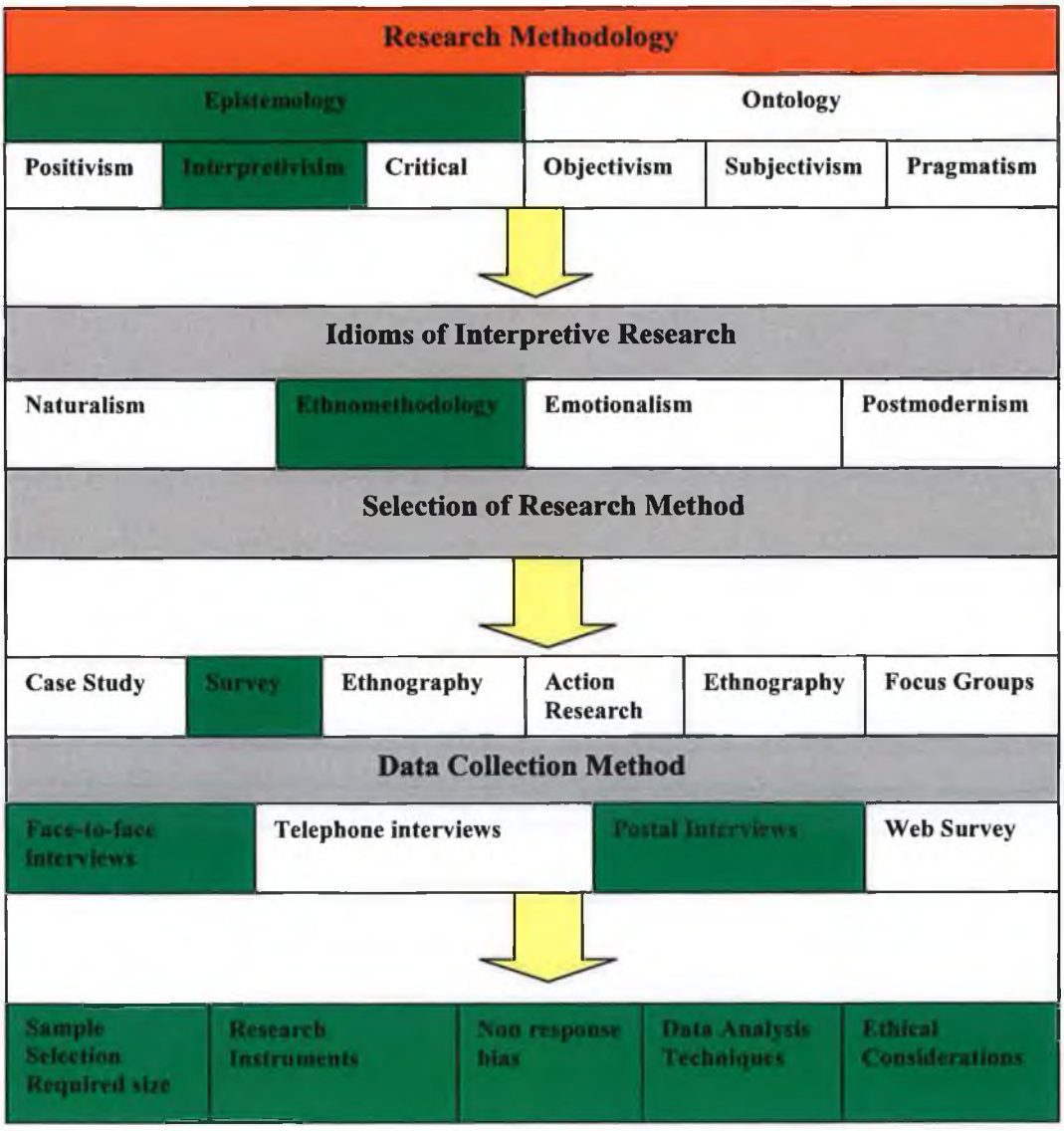

Figure 3.1: *Summary of the Research Approach Chosen*

CHAPTER FOUR: AN ANALYSIS OF THE BMW REGION

4.1 Introduction

The peripheral region chosen for this study is the BMW region in Ireland. As stated in section two of this chapter, a cluster is a prerequisite and a central component of a RIS, therefore a cluster must be identified. This section will develop a profile of the BMW region. The infrastructure, incentives and institutions that surround the identified cluster will be detailed in this section. This data will be then be augmented by the research findings in Chapter Five.

4.2 The BMW Region

The BMW region in Ireland comprises of thirteen counties and covers a large and diverse area (47% of the land area of Ireland). It is predominantly rural, 63.3% of the population in the BMW region live in rural regions compared to 30.5% in the South & East (S&E) region (CSO, 2006) It has a low population density, 27% of the population of Ireland, 1.2m in 2010 (BMW Assembly, 2011), highlighted in Table 4.1 below. It is highly reliant on traditional industries such as agriculture and manufacturing and accounts for 19% of Ireland's GDP in 2008.

Table 4.1: *Comparison of Population and Area by Region, 2010*

	BMW	S&E	Total
Area (sq km)	32,450	36,446	68,896
Population	1,204,300	3,266,400	4,470,700
Population per sq m	37.11	89.62	64.89

Source: CSO Preliminary Census Report 2010

The BMW region and the S&E region are compared from an economic perspective below in Table 4.2

Table 4.2: *Economic comparison of BMW & S&E regions*

	Year	State	S&E	BMW
*Pop (m)	2010	4,470,700	3,266,400 (73.1%)	1,204,300 (26.9%)
*Employment (000s)	2010	2,155.8	1,382.8	474.1
*Unemployment Rate %	2010 Q3	13.9	13.5	15.1
*Disposable Income per Capita (state = 100)	2008	100	103.1	91.5
Lisbon Strategy Performance Measure	Lisbon Index 2010 (268 NUTS11 Regions)	11th (EU 27)	113	147
*GVA per person (state = 100)	2007	100	111.2	69.3
*% of Labour Force with a Third Level Qualification	2008 Q3	30.5%	34.6%	36.1%
Total R&D Expenditure as a % of GDP (2007)			1.28	1.29
No. of Universities	2010	7	6	1
No. of Institutes of Technology's	2010	14	9	5

Source: Central Statistics Office and Eurostat (various reports) (2007-2010)

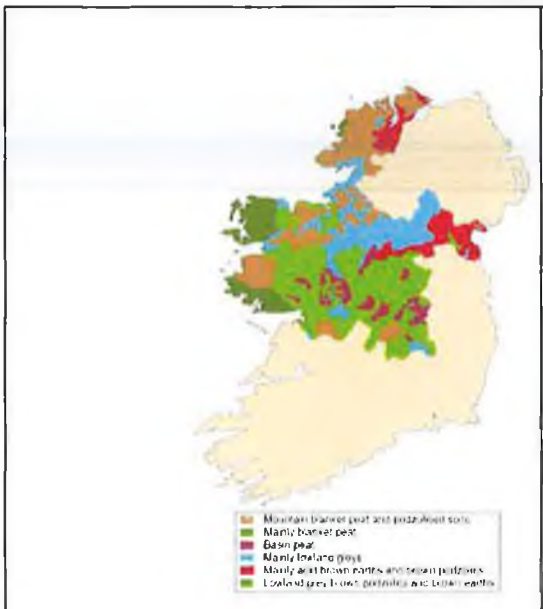

Figure 4.1: *Soil makeup in the BMW region*

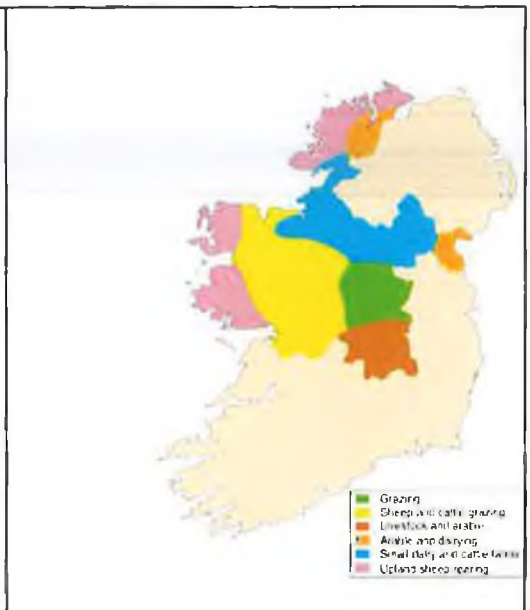

Figure 4.2: *Type of farming in BMW region*

Farming continues to make a considerable economic and social contribution to the region but the nature of the agricultural land varies, from poor quality mountainous land along the western seaboard to large peatlands in the midlands.

The BMW Region is characterised by a high dependency on cattle and sheep grazing with less tillage and large dairy farms compared to the S&E region.

Farm income is very low, and the region as a whole is regarded as a disadvantaged area (only 5% of farms are considered economically viable by the EU) therefore qualifying for the highest grant / subsidies from the Common Agricultural Policies (CAP) of Europe. Tourism has enormous potential to grow within the BMW Region, as it is an area of outstanding natural beauty and has developed some of its outdoor activities as tourist attractions (BMW Report 2005).

Although rurality and low population density are evident, there is however a strong and developing network of medium and larger sized towns such as Sligo, Letterkenny, Dundalk, Cavan, Castlebar and the larger towns of Athlone, Mullingar, Tullamore and Galway City. Table 4.3 below highlights the population increases in the Gateway and Hub Towns between 2002-2006.

***Table 4.3**: Main Towns in the BMW Region, 2006*

Gateways (100,000+)	2002	2006	Growth
Galway City & Suburbs	66,163	72,729	10%
Dundalk	32,505	35,085	8%
Sligo City	19,735	19,402	-2%
Letterkenny	15,231	17,586	15%
Athlone	15,936	17,544	10%
Tullamore	11,098	12,927	16%
[illegible]	[illegible]	[illegible]	[illegible]
Hubs			
[illegible]	[illegible]	[illegible]	[illegible]
Ballina	9,647	10,409	8%
Cavan	5,647	7,883	29%
Tuam	5,947	6,885	18%
Monaghan	5,936	6,710	13%

Source: CSO Census of Population, 2006, BMW Regional Assembly 2011

The National Spatial Strategy (2002-2020), a twenty-year coherent national planning framework for Ireland, recognises and calls for a strengthening of these urban areas. It

has done this by assessing certain areas as 'Gateways' and 'Hubs'. The reasoning behind this was to bring about increased regional development and to act as a counter balance to the Greater Dublin Area (GDA). The GDA has accumulated a majority share of Ireland's economic activity and wealth over the last number of years. Policy makers in the Irish Government recognise the importance of these Gateways and Hubs as drivers for regional economic growth. *'Strong cities and urban areas are key to growth of regional and national economies' (Forfás, 2006:6)* .The importance of counteracting the balance of growth in Ireland was one such priority in the BMW Regional Operational Plan (Border Midlands and Western Regional Operational Programme EU Regional Policy, 2007-2013).

4.2.1. Regional Support Infrastructure

Regional Support Infrastructure includes the hard support infrastructure such as physical, technological and knowledge infrastructure developed within the region. It also includes soft support infrastructure such as innovation, R&D and skills base, entrepreneurial culture and the support institutions in the region.

4.2.1.1 Hard Support Infrastructure

This refers to the supporting physical infrastructure such as roads, public transport, airports, energy, communication links, etc. The quality of the physical infrastructure and provision of a well-functioning public transport infrastructure and high speed broadband is essential to all regions. Broadband is particularly beneficial to SMEs in peripheral regions as it enables them to share information regardless of their physical location (BMW Regional Assembly, 2004).

Another important consideration is the distances and times that people are willing to travel to employment, and distances that company owners and employees deem reasonable for meetings and networking. Clustering is facilitated by proximity, the underlying rationale is that businesses that are closer to one another have advantages over businesses outside the cluster, proximity provides informal contacts and opportunities for knowledge exchange, facilitates face-to-face communication, and allows trust to be built between the firms, which heightens the innovativeness of the cluster (Saxenian,1996; Simmie, 2002)

4.2.1.1.1. Physical Infrastructure

(i) Roads

The BMW region is predominately rural with a widely dispersed population; therefore transportation infrastructure is vital for the region. At end of the 2000-2006 National Development Plan, over €1,330m had been invested in non-national roads projects by Local Authorities in the BMW Region, contributing to the improvement and restoration of 28,392 km of non-national roads. However inadequacies still remain as poor quality infrastructure is a major problem within the BMW region. According to the National Roads Authority (NRA) in the BMW region there are significant parts of the national primary network well below the Level of Service (Border, Midlands and Western Region Operational Programme 2007-2013).

If infrastructure is viewed as inadequate, businesses based in the region can be disadvantaged from competing on a global scale. In order to attract major industries into

the region, access needs to be improved. One major improvement that occurred in December 2009 was the opening of the N6 (Galway to Dublin motorway), reducing commuting time from Dublin to Galway significantly.

(ii) Public Transport

Rail transport is also seen as problematic in the BMW region. According to the Central Statistics Office (2007) Irish registered good vehicles transported almost 315 million tones of goods by road in 2007, an increase of 203% in ten years. According to the Western Development Commission (2008), over the largest rail freight traffic movement is from Mayo where 900 trains transport goods to Waterford Port. This movement of freight in turn eliminates 16,000 truckloads from the roads.

Since 2006, lines and trains have been upgraded, transforming Iarnród Éireann's (Irish rail) Intercity fleet from the oldest in Europe to the most modern, but the frequency of service still remains low. Iarnród Éireann's re-examined this in 2009 and provided more connections to the West by offering more frequent services. Table 4.4 below highlights the frequency of rail connections for key BMW towns.

Table 4.4: *Frequency of Rail Connections for Key BMW Towns*

Route	No. of Services each Weekday
Dublin – Galway – Dublin	9
Limerick – Galway – Limerick	5
Dublin – Sligo – Dublin	8
Dublin – Westport/Ballina – Dublin	4
Ballina – Manulla Junction – Ballina	6

Source: Irish Rail, 2008

One major issue is that there is currently no direct north-south routes thereby making commuting to other regions other than the East very difficult. The only connection is from Galway to Limerick. There is no direct connection from the BMW region to Cork / Kerry or to Belfast. Athenry is the only town in the BMW Region with a rail commuter service. The re-opening of the Western Rail Corridor would enable ease of access to airports in the BMW region and easier access for people within the region. The Western Rail Corridor is funded by the Irish Government as part of the Transport 21 Investment Programme. Transport 21 is a Capital Investment Programme under the NDP through which the transport system in Ireland is to be developed, over the period 2006 to 2015.

The term "Western Rail Corridor" refers to the rail passenger and freight route from Sligo or Ballina through to Limerick (distance of 234kms) with onward connections to the south-west and the port of Rosslare. Figure 4.3 below highlights this.

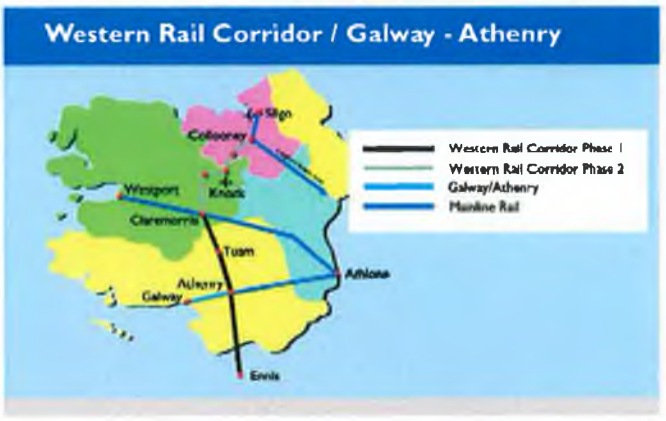

Figure 4.3: *Western Rail Corridor / Galway – Athenry*

Due to the economic issues when writing this research, work on this rail line had been put on hold.

(iii) Air Access

The BMW region has one international airport, Ireland West Airport Knock (IWAK) built in 1981 offering flights to over nineteen scheduled destinations and three charter destinations in 2012. It serves a catchment area of 900,000 people within a 90-minute drive (21% of Ireland's population). Galway airport is the second largest airport within the region and has grown considerably in the last few years providing flights within Ireland and to the UK and France, however since 2011 the airport has received reduced funding from Government with the more viable airports in Ireland being supported. Other smaller airports in the region are Sligo and Carrickfin (Donegal), providing flights within Ireland and to UK destinations. Table 4.5 below shows the main airports throughout the south of Ireland highlighting Ireland West Airport Knock in the BMW region as the fourth busiest in Ireland.

Table 4.5: *Passenger numbers 2004-2008 and percentage international / domestic*

Airport	2004	2008	% change 2004-2008	% International	% Domestic
Dublin	17,138,373	23,057,205	37.2	96.0	4.0
Cork	2,254,251	3,259,109	44.6	86.2	13.8
Shannon	2,395,116	2,956,951	23.4	92.8	7.2
Knock	368,997	629,951	70.7	98.1	1.9
Kerry	378,654	426,115	12.5	70.4	29.6
Galway	225,430	266,473	18.2	66.4	33.6
Waterford	60,875	144,253	136.9	96.5	3.4
Donegal	42,675	65,539	53.5	26.2	7.3
Sligo	41,053	42,493	3.5	22.1	77.8

Source: WDC: Air Access and the Western Region: A Regional Perspective (data from CSO Transport, 2008)

The four regional airports in the BMW Region have received over €7m in investment through the NDP (2000-2006) and have reported 902,000 passengers in 2006 (BMW Regional Assembly Report 2007). It has to be also mentioned that even though Shannon International Airport is not in the BMW Region it still plays a major role due to its close proximity to Galway (approx 90km). It is currently Ireland's fourth largest airport after Belfast and had reported approx 3 million passengers in 2008.

(iv) Energy Requirements

Ireland is currently dependent on fossil fuels and is highly dependent on importing its energy requirements. One new major mineral find has been the Corrib Gas Field off the Belmullet coastline in Mayo. Deposits are valued at well over €1 billion euro. At the time of writing this research, there were problems over the siting of the gas terminal which has led to delays. However one benefit from this mineral find has been the Gaswest Project. This €200 million Mayo-Galway pipeline (underwritten by the Corrib Partners) was completed on schedule in 2006. The Gaswest Project, a €40 million, three-year development project for the West of Ireland, will make natural gas available to seven towns in Co. Mayo and four in Co. Galway along the route of the pipeline. Natural gas should benefit all businesses in the region. Its availability can enhance the

attractiveness of towns, help development of indigenous industries and attract inward investment.

Figure 4.4: *Location of Corrib Gas Field*

4.2.1.1.2 Technology Infrastructure

(i) Broadband

High-speed broadband is an essential element to all businesses throughout the world as it enables business to business interaction, thus reducing peripherality. The roll-out of broadband throughout rural Ireland has been slow and Ireland lags behind most EU countries in terms of broadband access and connectivity, in particular the BMW region. According to the CSO's Information Society statistics Ireland still lags behind the rest of the 27 countries in the EU, although 43% of Irish households now have a broadband connection compared with 7% in 2005. Of the original 15 EU countries, Ireland has the fourth lowest household broadband usage. This places it on a par with Lithuania and 3pc more than Latvia. It was 31% lower than the Netherlands and Denmark.

Table 4.6 below looks at % of households in the BMW, S&E and Ireland with a computer and with internet access. It highlights the fact that the availability of broadband in the BMW region is much lower than the S&E region

Table 4.6: *Level of domestic ICT usage in BMW, S&E and State 2000-06*

	2000	2003	2004	2005	2006	2007
% of Households with a Computer						
S&E	34.5	45.2	49.4	57.2	61.4	68.1
Ireland	32.5	42.2	46.2	54.9	58.5	65.4
% of Households with Internet Connection						
S&E	22.2	36.2	41.1	47.3	51.7	60.0
Ireland	20.5	33.5	38.2	45.1	48.7	56.8

Source: CSO - Quarterly National Household Survey: June 2003, June 2004, June 2005, February 2006 and February 2007.

Table 4.7 below breaks down the regions further and highlights the difference between the regions. 53% of households with a PC in Dublin have broadband access to the internet compared with 22% in the Border and Midlands region.

Table 4.7: *PC & Internet access by region, 2006*

	% of households PC Ownership	% of households with PC Broadband	% of households with PC Other internet access
Midlands	52.4	22.5	54.6
West	53.2	42.226.0	55.5
Dublin	60.7	53.0	32.1
Mid East	63.8	33.7	49.8
Mid West	53.9	26.8	53.5
South East	54.5	30.0	53.2
South West	54.5	30.0	53.2
Total	56.6	35.3	47.1

Source: CSO – Census of Population 2006

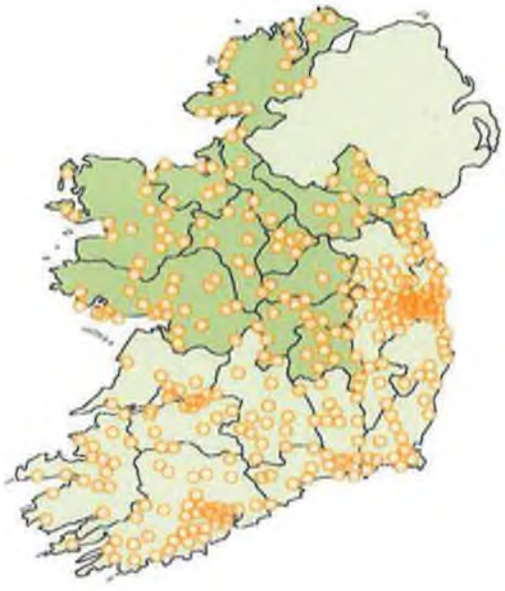

Figure 4.5: *Estimate Broadband Coverage in Ireland, 2000*
Source: Forfás, Ireland

The Government invested capital in the Metropolitan Area Networks (MAN) under the Regional Operational Programme 2000-2006 which included eleven towns in the BMW region. A total of €84m has been invested in broadband infrastructure, including 80 County and Group Broadband schemes (BMW Regional Assembly).

Wireless technologies have also been deployed in more remote areas, through initiatives such as the Group Broadband Scheme. This scheme was open to all rural communities of less than 1,500 people and operated from 2004-2006.

4.2.1.2. Soft Support Infrastructure

Local schools, universities, institutes of technologies, local trade and professional associations, economic development agencies and other public agencies support their activities and are key ingredients in a high performance cluster. The quality of this soft support infrastructure, and the extent of teamwork within it, are very important parts to the development of any cluster.

Higher and further educational institutions, as stated earlier, play a central and prominent role within knowledge creation and innovation. The Irish Government

realised this and developed a wide range of Regional Technical Colleges (RTCs) now called Institute of Technologies (IoTs) throughout the country in the 1970s. The BMW region in particular has benefitted enormously from this. The availability of a strong skills base and educational capabilities are very important components to a RIS.

4.2.1.2.1 Knowledge Infrastructure

(i) *Strong innovation / R&D base*

Innovators generate and commercialise new ideas, find new markets and develop more efficient production processes. Universities and state agencies can play a role in this through government policy as they can help generate and attract knowledge to a region and also act as training providers. As national policy makers position Ireland as a knowledge-based economy, the BMW region in Ireland must be able to compete effectively. The BMW region has one University - NUI Galway, and five Institutes of Technologies. These are Galway-Mayo Institute of Technology (GMIT) with five campuses, Athlone Institute of Technology (AIT), Institute of Technology Sligo (IT Sligo), Letterkenny Institute of Technology (LYIT) and Dundalk Institute of Technology (DKIT).

Several initiatives have been introduced in Ireland to encourage collaboration between academia and industry in Ireland. Enterprise Ireland (the state agency for enterprise development) have introduced various research partnerships with Third level institutes throughout Ireland. These research partnerships enable companies to access funding and graduates to support research opportunities within industries. One example of such an initiative is the *Innovation Voucher Scheme* introduced in 2007, a programme which incentivises small and medium enterprises to access advice, expertise and information from accredited knowledge providers. This is hugely beneficial to the large number of SMEs, prominent in Ireland's business environment (especially the BMW region). This scheme enables managers to focus on the day-to-day running of the business whilst receiving input and expertise from the educational institutes with knowledge in the problem area. 25% of all national voucher redemptions (250 out of 1,000) were made by companies in the BMW region between 2007 & 2010, again well below the S&E region (BMW Regional Assembly 2011).

The Enterprise Ireland-funded *Technology Transfer Support Initiative* (TTSI) also enables companies with commercial potential access to research and employs strategies of how to best exploit that research. *'The program is designed to build bridges between the university and industry'* (NUIG website) as it enables companies the potential to collaborate with the third level institution which may be difficult to access otherwise. Up to Nov 2009, six Institutes from the BMW region have been approved for TTSI funding totalling €1.9m, 46% of the total of €17.1m awarded to Institutions across Ireland (BMW Regional Assembly, 2011). A report from the Expert Group on Future Skill and Research Needs of the International Financial Services Industry (Dec 2007) however found there was very little evidence of technology transfer from Third level Institutions (TLIs) to industry. In addition it was also reported that there is a *'general lack of interest from industry in research activity in Irish universities.'* A report by Benschop and Sturrus (2007) on Irish Innovation Policy gives some reasons for this:

- Firstly companies lack capacity to establish a collaboration group.
- Secondly companies lack personal contacts within the third level sector
- Thirdly is the issue of different goals. Companies require practical results while universities want to publish their research yearly.

Further evidence from the CSO and Forfás (2008) showed that the levels of co-operation with TLIs was greatest with larger enterprises with more than 250 employees (26.7%) but co-operation with small (4.3%) and medium sized enterprises (9.7%) remained very low. Just 6.8% of all firms who responded to the survey had cooperated with a TLI. Total R&D spending in Ireland was 0.92% of GDP in the BMW region and 1.16% of GDP in Ireland. This compares with the EU25 average of 1.9% (GDP). The Higher Education sector has significantly increased its R&D spending from €322 million in 2002 to €600.6 million in 2006.

***Table 4.8**: Selected Indicators of Regional R&D Performance compared with State and EU in 2003*

	EU 25	Ireland	BMW Region
Total Expenditure on R&D as % of GDP	1.9	1.16	0.92
Business Enterprise Expenditure on R&D as % of GDP	1.22	0.9 (1.06 2006)	0.65
Government Expenditure on E&D as % of GDP	0.25	0.09	0.08
Higher Education Expenditure on E&D as % of GDP	0.41	0.29	0.20
% of Innovation-active Enterprises	42% (EU 27)	52%	50%
Patents per million of population	127.9 (EU 27)	77.3	n.a.
Science and Technology Graduates per (000s)	12.4 (EU 27)	23.1	n.a.
Share of Women Researchers	25.8 (EU 27)	27.8	n.a.

Source: GEM Report

This data indicates that the BMW Region is below the national average in terms of R&D expenditure, and considerably below the EU average.

***Table 4.9**: R&D Expenditure by Region (2003, 2005, 2007)*

	2003			2005			2007		
	Total Business R&D Exp (€k)	**Total GDP (€m)**	**BERD as a % of GDP**	**Total Business R&D Exp (€k)**	**Total GDP (€m)**	**BERD as a % of GDP**	**Total Business R&D Exp (€k)**	**Total GDP (€m)**	**BERD as a % of GDP**
BMW	166,000	21,182	0.8%	341,302	25,194	1.4%	298,972	29,487	1.0%
S&E	910,000	94,929	1.0%	987,342	108,431	0.9%	1,304,213	129,988	1.0%
State	1,076,000	116,111	0.9%	1,328,744	133,625	1.0%	1,603,185	159,475	1.0%

Source: BMW Regional Assembly, May 2011

The main sources of funding have been driven by direct government funding through Science Foundation Ireland (SFI), Enterprise Ireland, the Higher Education Authority (HEA), the Health Research Board (HRB) and the Research Councils. SFI awards funding to support scientists and engineers working in the areas of biotechnology, ICT and sustainable energy and energy-efficient technologies. Between 2001 and 2010 SFI awarded grants to 27 Institutions totalling €1.5 billion which included €2.2 million supporting conferences and workshops. Of the 27 Institutions receiving grants, five were located in the BMW region namely, NUI Galway, Teagasc, Dundalk IT, IT Sligo and Athlone IT. These five Institutions in the BMW region received grant awards totalling €173.3 million being 11.33% of the total grants awarded. NUI Galway was by far the largest beneficiary receive grant awards totalling 168.6 million (97% of the total awarded to the institutions in the BMW region) BMW Regional Assembly, 2011. This emphasises that TLI's in the BMW region are not accessing this fund like their counterparts in other parts of Ireland.

The *Programme for Research in Third Level Institutions* (PRTLI) is operated by the Higher Education Authority (HEA). This programme allocates funding on a competitive basis to Third-Level Institutions. Five cycles of funding have been allocated to-date totaling €1,200,000,000 of investment. Table 4.10 highlights the €169.5 million awarded in funding to HEIs in the BMW region across HEA funding programmes.

***Table 4.10**: Selected Indicators of Regional R&D Performance compared with State and EU in 2003*

	BMW Total	State Total	BMW % of State	Notes
Programme for Research in Third-Level Institutions Cycles 1-5	€147,000,000	€1,200,000,000	12%	1998-2010
Technology Sector Research – TSR1	€3,740,360	€14,397,870	26%	2004-2008
Technology Sector Research – TSR1€	€620,000	€2,515,000	25%	2006-2010
Technology Sector Research – TSR1	€4,164,560	€11,303,508	37%	2004-2008
RERC	€3,397,345	€28,020,000	12%	2007-2010
Research Facilities Enhancement Scheme	€10,670,000	€57,996,850	18%	2007-2010
HEA Total	**€169,952,535**	**€1,314,233,288**	**13%**	

Figure 4.6 below presents a detailed regional breakdown of research funding under the PRTLI Cycles 1-3 in relation to the research centres and Institutions funded

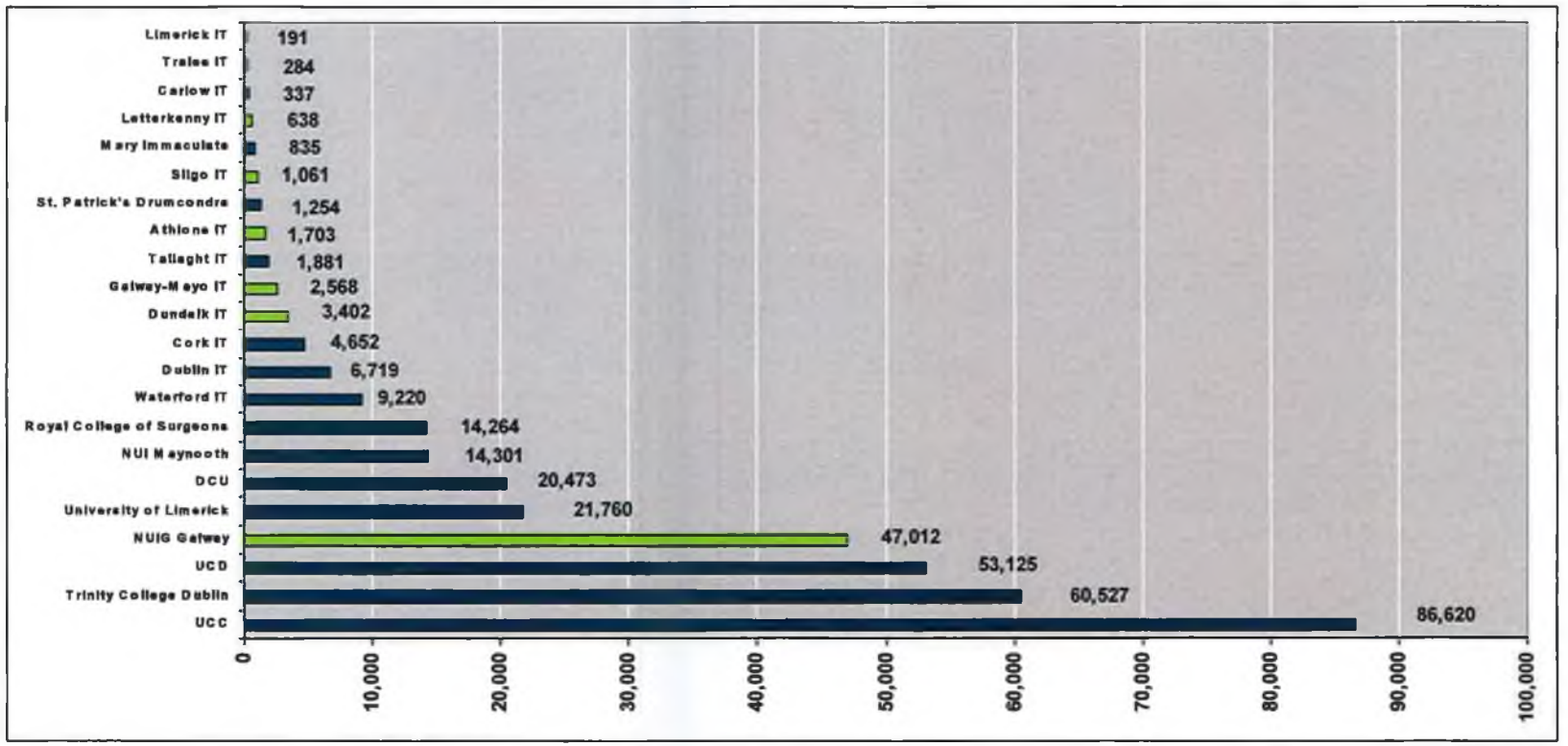

Figure 4.6: *Direct research income[2] by third level institutions in the state, 2005/06*
Forfas The Higher Education R&D Survey 2006 (HERD) – Aug 2007

[2] Spending on R&D in the higher education sector in Ireland was €600 million in 2006. Direct research income to the Irish higher education sector amounted to €352 million. It includes funding from the Irish exchequer, EU sources, individuals and businesses. It excludes indirect funding totalling €248 million from the Higher Education Authority block grant.

'Just 12% of this fund was invested in Third Level Institutions in the BMW region. NUIG received 93% of the total investment for the Region' (BMW Report 2008). The Institutes of Technology's received only small amounts of this funding. NUIG Galway was the only Third Level Institute in the region to attract funding (€23 million) in Cycle 4.

Another programme, *The Technological Sector Research Initiative* (TSRI), is a research fund available on a competitive basis to the fourteen Institutes of Technology. The purpose of this is to support and strengthen the research capacity of the sector by enabling research projects. The total funding awarded under the 2000-2006 NDP was €38.9m. Due to the limited budget available the Institutes of Technologies may find it difficult to improve their research infrastructure. *'Given the crucial role of the five Institutes of Technology (IoTs) in the development of the BMW Region and the lack of funding awarded under PRTLI it is once again a disappointment to note that just 19.4% of the TSRI funding has been awarded to the IoTs in the Region'* (BMW Regional Audit).

(ii) Centres of Excellence

Since 2005 Institutes of Technology's (IOT's) have developed Centres of Excellence in their respective regions. Seventeen Centre's of Excellence were developed throughout Ireland in eleven IOT's in the order of €1.2 to €2 million for a 3 to 5 year period. This initiative occurred through the *Applied Research Enhancement* (ARE) *Programme* which is targeted at the Institutes of Technology and administered by Enterprise Ireland. It aims to develop a maximum of three Centres of Excellence in each of the IoTs. This programme has been introduced to develop research capacity in individual colleges. Within the BMW region, there have been a total of 8 centres funded through the programme with grant aid totalling €14,528,209. Four centres are currently being funded. NUIG also has two centres of excellence funded by SFI and the HEA, these are called Centres for Science, Engineering and Technology (CSETs)

Table 4.11 below highlights these different Centres of Excellence.

***Table 4.11**: Centres of Excellence in the BMW Region*

IOTs	Centres of Excellence
GMIT	*GmedTech* established in 2006 engages with medical device companies to identify product test needs. Medical Technologies Centre enables implantable medical products to be tested in environments that closely match the in-vivo condition. No longer in receipt of ARE funding. *Shelltech* Developing innovative technologies to optimize the delivery of high quality live shellfish products. No longer in receipt of ARE funding.
Athlone IT	*SUNAT* - research has a focus on facilitating the rapid prototyping, creation and delivery of mobility enabled applications by developing a Service Enterprise Architecture for Adaptive Mobility (SEAAM). Currently being funded under ARE funding.
Sligo IT	*Centre for Design and Innovation* – Assists companies to develop their design capabilities. No longer in receipt of ARE funding.
Letterkenny IT	*Cambio Centre* for Applied Marine Biology focus on Aquaculture and Fisheries; Biomedical Marine Research; Marine Food Processing and Waste Remediation. No longer in receipt of ARE Funding *WiSAR Lab:* Wireless Sensor Applied Research Laboratory. Currently being funded by ARE funding.
Dundalk IT	*ICBC* Ion Channel Biotechnology Centre an industry-led corporation and the commercialisation arm of the Smooth Muscle Research Group targeting biotechnical and pharmaceutical companies. Currently being funded by ARE funding.
NUIG	*Regenerative Medicine Institute a Research Institute conducting Research into Regernerative Medicine Therapies.* Funded under CSET's Funding *Digital Enterprise Research Institute (DERI)an approved Research Institute looking into the next wave of internet technologies* Funded under CSET's Funding

Source: BMW Regional Assembly, 2011

In addition to these Centres of Excellence, the Institutes of Technology's and Universities have also developed incubation facilities on campus, which will be outlined below.

(iii) Incubation Centres

'In many countries, business incubators have become an important tool for local economic and employment development. There are about 550 incubation centres in the United States, some 200 incubator-type structures in France, and more than 100 in the

United Kingdom with these numbers growing rapidly' (OECD 2001; 260) The centres have co-located space with most (not always) providing business advisory services. The BMW region has seven incubation centers (NUIG, Dundalk IT, Athlone IT, GMIT Galway and Castlebar, IoT Sligo and Letterkenny IT). These centers are set up to encourage local entrepreneurs and new start-ups and also a resource for spin-off companies based in academic R&D.

The Enterprise Platform Programme's (EPP) hve also been delivered through the incubation centres. These are one year full-time training and enterprise support programme aimed at addressing and supporting the needs of an entrepreneur in a business start-up situation. This programme was renamed the New Frontiers Programme in 2012.

In order for companies in the BMW region to compete internationally they will face some key challenges such as the level and efficiency of innovation activity which is viewed to be higher in densely populated regions (cores) than in more remote and peripheral areas (Fritsch, 2004). In order for companies in the BMW region to compete internationally, research collaboration and opportunities must be explored and encouraged. Colleges can do this by continuing to produce high calibre graduates, offering more courses to help strengthen and develop indigenous industries in the region and developing its IOTs into research and innovation centres. Research activities in turn will help to encourage more R&D activity within industries in the region. This in turn may help to stimulate and develop more clusters leading to better possibilities of RIS'.

4.2.1.2.2 Strong skill base

Due to the emphasis on innovation, the skills and knowledge of the work force are often top of the list of priorities for a business. As businesses become more technology dependent, they need more highly skilled, educated and talented employees. Innovative businesses will locate where there is a skilled workforce. Regions are beginning to use incentives to recruit talent. The BMW Region has a relatively well educated workforce, with a high proportion of young people sitting their leaving certificate and a high number also continuing onto third level, *'over 40% of employees in the medical device*

and diagnostic sector have third level education' (BMW Regional Audit 2004). Figure 4.7 below highlights individuals who have completed full-time education and at what level in the BMW region

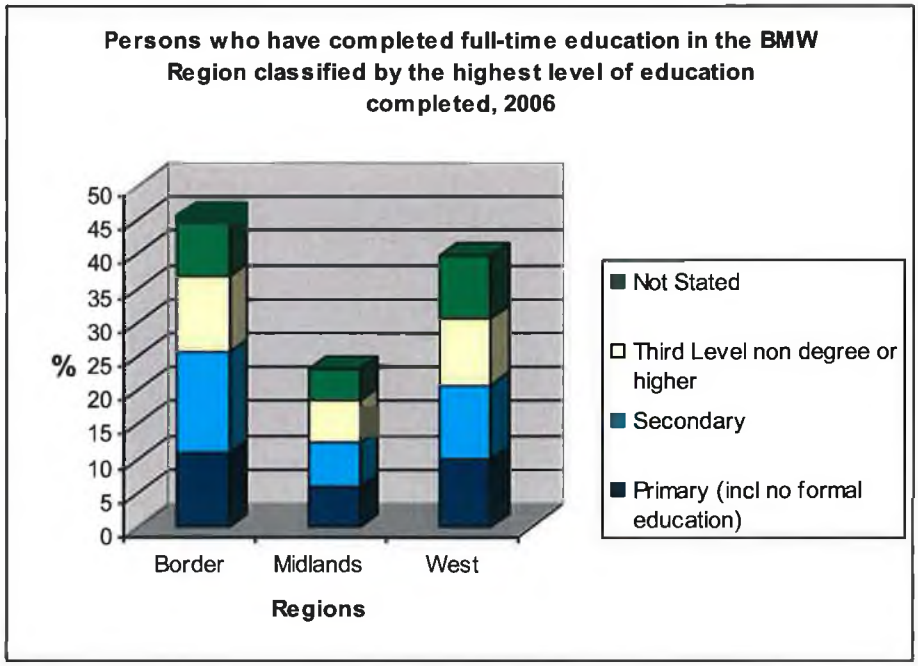

Figure 4.7: *Persons who have completed full-time education in each county in the BMW region classified by the highest level of education completed, CSO 2006*

The Border and West regions have high secondary school completion rates and high university participation rates. It is notable that whilst the Region provides 28% of national university students, only 13% of graduates coming from the BMW Region are employed within the Region. *'The lack of suitable job opportunities for skilled labour along with the lower level of economic and social development in the Region would appear to be significant factors in the choices made by graduates'* (BMW Regional Audit, 2004).

This in turn, creates an additional challenge for the region, as many of these high skilled graduates relocate to other regions. Less advantaged and peripheral regions with no major urban area such as Mayo, Roscommon, Cavan, Leitrim, Monaghan and others have problems keeping their best and brightest secondary students who move to the

urban areas due to preferences of college courses, quality of social life, employment prospects etc.

Galway on the other hand not only has a better chance at retaining its students but also attracts a large influx of students and adults looking to pursue college courses or employment opportunities. Workers find it advantageous to be in a place where there are many possible employers. This minimises the risk from a layoff or a firm failure and creates additional opportunities for advancement. The possibility of adult education should also be a very important objective for a peripheral region. Vocational Educational Committees (VECs) enable lifelong learning opportunities by providing education and training in every county. Universities and IoTs also offer lifelong learning courses and outreach programmes to people living in rural communities which is a very important resource available to people living in the BMW region.

Table 4.12 below summaries enrolments into Colleges based in the BMW region and ways in which this took place. Distance and e-learning is quite low among all Colleges in the BMW region, with the exception of IT Sligo.

***Table 4.12**: Higher Education Enrolements in the BMW Region 2009-2010*

	FT	PT	Distance	Elearning	In service	Grand Total
NUI Galway	13,469	2,618	38	10	405	16,540
Athlone IT	3,364	1,207	13	0	0	4,584
Dundalk IT	4,418	380	0	0	0	4,528
GMIT	5,169	1,195	28	0	0	6,392
Letterkenny IT	2,549	437	0	0	0	2,986
IT Sligo	3,673	290	623	405	4	4,995

Source: BMW Regional Assembly, May 2011

4.2.1.2.3 Presence of large firms can lead to a strong entrepreneurial culture

Entrepreneurial capacity helps drives regional development. Naturally some places have more entrepreneurs or more conducive environments to entrepreneurship than others, and this shapes their development. For example, '*the presence of 'anchor' firms is argued to enhance the availability of skilled labour, specialised suppliers and knowledge spillovers among firms in a cluster* (Feldman 2003, Agrawal & Cockburn 2003) The origins of some clusters can be traced to the employees of one or two companies who left to start their own companies e.g. when Digital closed in Galway this amounted to a large amount of employees setting up their own business. Chas Taylor, a serial entrepreneur, is frequently quoted as one such individual in the region. He previously worked for CR Bard in Galway, now called Medtronic, before setting up MedNova with a colleage. MedNova was subsequently taken over by Abbott. Taylor then set up Novate before being asked to join Veryan in an executive capacity.

Another example is the hosiery firms in Northern Italy's Castle Goffredo. These were established by skilled workers of the German-owned company Noemi who, when the firms declined in the 1950s, bought surplus equipment and became entrepreneurs.

Multinationals can help to stimulate this enterprise culture. There are numerous examples of large companies in the Biomedical Sector in BMW region. Some of these include: Abbott, Baxter, Boston Scientific, Elan, Harmac Medical, Johnson and Johnson, Mednove, Medtronic, Merit Medical, and Tyco Healthcare. In the BMW region, Galway has the largest amount of people employed by MNE's. Galway, Mayo and Roscommon have seventy US multinationals employing over 14,000 people directly and supporting thousands indirectly. Almost 40% of total employment in the medical device sector in the country is the west region (Forfás, 2008). Table 4.13 below highlights the various sectors of employment in both indigenous and multinational companies in Ireland and the BMW region. Employment in the electrical and optical equipment sector is highest in the BMW region and the majority is with multinational companies.

***Table 4.13:** Employment by Sector – MNCs and Irish Indigenous Industries*

Employment by Sector (2006)	All regions – National			BMW		
	Total	MNEs	Irish	Total	MNEs	Irish
Food products, beverages and tobacco	53,091	-	-	15,989	-	-
Textiles and textile products	4,439	-	-	1,540	-	-
Wood and wood products	3,224	-	-	3,224	-	-
Pulp paper and paper products; publishing and printing	2,410	-	-	2,410		
Rubber and plastic products	10,126	3,273	6,853	4,004	1,762	2,242
Chemicals chemical products and man-made fibres	24,376	19,398	4,978	3,077	1,637	1,440
Other non-metallic mineral products	10,965	1,544	9,421	3,739	508	3,231
Basic and fabricated metal products	15,674	2,412	13,262	4,382	362	4,020
Transport equipment	8,864	5,904	3,260	1,200	349	851
Total manufacturing						
Total	**189,201**			**61,254**	**20,304**	

Source: Census of Industrial Production 2006

Global Entrepreneurship Monitor (GEM) Report

The Global Entrepreneurship Monitor (GEM) Report [3] for Ireland 2008, found that 7.6% of the adult population living in Ireland are involved in early stage entrepreneurial activity, a decrease from 8.2% in 2007. The rate at which entrepreneurs are setting up a business in Ireland (4.3%) was comparable to the rate reported in 2007 and was well above the EU (2.7%) and OECD (3.3%) averages and compared favourably to the rate prevalent in the United States (5.0%) (GEM Report 2008).

Worryingly the rate of business start-ups is only 50% of the national average in the BMW region, Galway having the highest start-up rate. Table 4.14 below highlights business start-ups by county in Ireland with Galway being third highest.

These figures do not take into consideration any new business start-ups, which were not registered as companies, i.e. sole traders. In Ireland, new start-up figures are not available regionally.

[3] The Global Entrepreneurship Monitor (GEM) is a not-for-profit academic research consortium that has as its goal making high quality information on global entrepreneurial activity readily available to as wide an audience as possible. GEM is the largest single study of entrepreneurial activity in the world. Initiated in 1999 with 10 countries, GEM 2010 is conducting research in 59 countries.

Table 4.14: *Top Locations for Business Start-Ups in Ireland*

Locations	2006	2007	2008	2009
Dublin	7,006	7,686	6,516	6,129
Cork	1,524	1,871	1,409	1,227
Galway	1,193	799	651	591
Limerick	676	689	538	454
Kildare	388	823	615	564
Donegal	336	499	312	215
Meath	378	653	551	467
Tipperary	231	466	295	327
Kerry	301	473	314	237
Wexford	290	475	328	251
Louth	190	456	395	365
Wicklow	228	481	411	427
Clare	229	378	323	313
Mayo	184	299	249	195
Waterford	-	292	246	209
Kilkenny	-	248	215	181
Carlow	-	178	143	119
Westmeath	165	326	218	212
Laois		187	154	136
Monaghan	-	189	143	99
Cavan	-	242	162	116
Offaly	-	195	139	148
Sligo	-	154	147	109
Leitrim	-	116	53	17
Roscommon	-	151	102	120
Longford	-	116	62	73

Source: Bank of Ireland Business Banking Start-Up Barometer

**From 2008 onwards all 26 counties have been included. The top 18 counties were initially chosen, increasing to 26 in 2007*

Table 4.15 below highlights VAT registered enterprises. New VAT registration figures are available on a regional basis which gives a good indication of new start-ups in the BMW region. The Border and West Region feature quite high in this with the Midlands having the lowest registered enterprise activity in 2006.

Table 4.15: *Distribution of VAT registered Enterprises in 2006 by NUTS II Regions*

Region	Active registered businesses 2006		Increase in active registered businesses 2001-2006		Rate of new registrations as a % of 20-64 age cohort in the region	
	Number	% of total	Number	% of total	2002	2006
Dublin	75,232	29%	21,732	23%	1.07%	1.31%
Border	28,582	11%	9,740	12%	1.08%	1.40%
South West	36,694	15%	12,786	16%	0.96%	1.37%
West	24,765	9.5%	9,154	11%	1.01%	1.45%
Midlands	14,208	5.5%	5,076	6%	0.84%	1.42%
Mid East	31,880	10%	10,935	13%	1.20%	1.50%
South West	27,182	10%	8,894	11%	0.93%	1.33%
Mid West	20,639	8%	6,641	8%	0.93%	1.26%
Total	261,182	100%	84,958	100%		

Source: Revenue

The Global Entrepreneurship Monitor (2008) highlight the variations across all regions, however the largest amount of entrepreneurs is found typically in regions with large urban and population bases. As highlighted in Table 4.16, below, the rate at which individuals are setting up new businesses is highest in the South East (6.1%) almost double the Border region (3.1%). The West is highly entrepreneurial in terms of total early stage entrepreneurial activity (10.0%) the second highest across the regions.

Table 4.16: *Entrepreneurial Activity by Region (2004-2008)*

Region	Expect to start a business in 3 years Percentage of all adults	Nascent Entrepreneurs Percentage of all adults	New firm Entrepreneurs Percentage of all adults	Early stage Entrepreneurs (TEA)[4] Percentage of all adults	Informal investment activity Percentage of all adults
Ireland (2008)	**10.0%**	**4.4%**	**3.9%**	**8.1%**	**2.8%**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dublin	10.5%	3.8%	3.6%	7.2%	2.3%
Mid-East	11.8%	5.8%	4.0%	9.5%	2.4%
Midlands	10.3%	5.7%	3.9%	9.1%	2.7%
Mid-West	13.0%	4.3%	3.5%	7.2%	1.4%
South-East	10.7%	5.1%	6.1%	10.7%	2.0%
South-West	8.6%	4.1%	3.3%	7.2%	3.1%
West	10.5%	5.4%	4.9%	10.0%	3.2%

Source: GEM Report 2008

According to the GEM report 2008, it is estimated that 350 individuals are setting up a new business every month and in general individuals living in the West region are very supportive of entrepreneurs and therefore the culture and social norms are very positive. In the Midlands region it is estimated that approx 150 people are setting up a business each month, this is the lowest across all regions and the rate of early stage entrepreneurial activity by women in the region (7.2%) is the highest in the country. The Border region has a relatively low rate of early stage entrepreneurs (7.9%) among its adult population compared to any other region and the rate at which individuals have recently started new businesses (3.1%) is the lowest of all regions. It is estimated that approx 250 individuals are setting up new businesses in the Border region each month.

The Audit of Innovation in the BMW Region undertaken by the BMW Regional Assembly (2004) has examined the level of innovation, entrepreneurship, start-ups and company performance in the BMW region. The key conclusions from this report were:

- The volume of new start-up businesses in the BMW Region is well below the national average and only half that in the S&E Region.

[4] Total early stage entrepreneurial activity(TEA) is a combination of nascent and new firm entrepreneurs. Nascent and new firm rates sum to less than the early stage entrepreneurship rate as some entrepreneurs are initially counted as both but are only counted once in the early stage rate.

- The BMW Region is less entrepreneurial than the S&E Region.
- The BMW Region is significantly below the national level based on the number of innovative companies. The level of R&D is low and tends only to be a part-time activity. Some of this may be due to the fact that the BMW region has smaller companies which are based on more traditional industries rather than high-tech industries. Industrial policy is often focused on the high potential start-up category which means many businesses in the BMW region are not able to benefit.

The challenge this poses for the BMW region was highlighted in a report of the Small Business Forum (2006) 'Small Business is Big Business'. This report highlights the key role of small and start-up businesses as engines of economic growth. Key points of interest from this report are that:

- Over 97% of businesses operating in Ireland today are defined as 'small' as they employ fewer than 50 people.
- There are approximately 250,000 small businesses in Ireland, of which approx 60,000 (24%) are in the BMW Region.
- They account for over 70% of gross value added (GVA) in Construction and 34% of GVA in indigenous Manufacturing.

This creates a lot of challenges for the region as there is an overreliance on micro businesses and on industries that are currently struggling in the economic downturn.
Looking at developing a RIS may be one way to counteract these challenges, even though firms are small, interactivity and collaboration between firms are the most important elements. Developing new innovative businesses is very important for the region.

4.2.1.2.4 Agency Support

Enterprise Ireland and the County Enterprise Boards (state enterprise working with smaller business at a local level) work with entrepreneurs throughout Ireland in order to encourage more company start-ups. Údarás na Gaeltachta, the state agency based in Irish speaking areas, helps businesses specifically based in these regions e.g. Donegal, Mayo

and Galway in the BMW region. Other agencies that offer support are Westbic (member of the European Business & Innovation Centre Network), Leader (work with rural based enterprises) and the Chambers of Commerce. The Incubation Centres (connected to the Institutes of Technology's) mentioned previously in this section are also engaged in developing more company start-ups in the high tech sectors also encouraging entrepreneurship and innovation.

4.2.1.2.5 Investment Organisations

The Irish Venture Capital Association – was established in 1985 in Ireland. In 1994 Enterprise Ireland established a five-year plan – the Seed and Venture Capital Measure (1994-1999) – co-financed by EU regional aid. The programme was targeted at establishing venture/seed capital funds. In 2001, the Seed and Venture Capital Fund Scheme was launched under the National Development Plan 2001-2006 with funds amounting to €95 million. The objective of the programme was to leverage €400 million in private funding. This had already been achieved by 2002, and by 2004 the 15 funds (with about €500 million in capital raised) established under the programme had made investments in 75 companies totalling €133 million (Enterprise Ireland, 2005).

(i) Seed and Venture Capital Programme

The Seed and Venture Capital Programme 2000-2006 was launched to improve access to finance for SMEs (small and medium sized enterprises) and has since been renewed 2007-2012. *'Over the past 16 years the Government, through Enterprise Ireland, has committed approximately €320 million, as a limited partner, in the majority of seed and venture capital funds that have emerged in Ireland. This includes investing in eight new VC funds under the currently 2007-2012 Seed & Venture Capital Programme'* (Enterprise Ireland website 2011). Examples would include the Bank of Ireland Seed &Early Stage Equity Fund, AIB Seed & Early Stage Equity Fund, Seroba Kernel Life Sciences Fund II Limited Partnership Fund etc.

There were a total of 91 investments in the Western region since the fund started which compared very favorably to other regions in the BMW. See Table 4.17 below.

Table 4.17: *Regional Breakdown of Investments – Cumulative to December 2009*

Region	Number of Investments	Total Invested Value €'000s
[illegible]	[illegible]	[illegible]
Dublin & County	343	197,975
Mid East	10	5,123
Mid West	38	11,104
Midlands	8	7,074
South East	10	5,801
South West	95	41,178
West	91	33,743
Other EU Regions	92	78,043
Total	700	382,693

Source: Seed and Capital Venture Programme (2000-2006, 2007-2012), Report 2009, Enterprise Ireland

According to the GEM Report in 2008, the rate of informal investments (3.2%) is very high in the West region, the highest of all regions.

(ii) Business Angels

Business Angels are private individuals who invest capital in companies during the early stages of development, also contributing expertise and know-how. They may or may not seek active participation in a company that they invest in. As bank financing can be hard to receive due to the high-risk element of early stage companies, business angels can be a good alternative. A Business Angel network is operational in the BMW region under Westbic based in Galway. It is in a pilot phase for the last two years with approx 250+ registered investors. Thirty four private equity deals were carried out by the Halo Angel Business Partnership since 2007. This brings the total Business Angel investment in Ireland up to almost €6m. Of these thirty four, seven occurred in the BMW region. The level of financial support ranged from €40,000 to €700,000.

(iii) Enterprise Equity

Established by the International Fund for Ireland in 1987, this is the only Venture Capital Group in the West of Ireland highlighting the lack of VC Companies in the BMW region. It initially operated in the border counties with Enterprise Equity in Northern Ireland and established an office in the BMW region in 2001. Their headquarters are in Dundalk but have offices also in Dublin, Cork. Since its foundation

it has invested in 73 companies. Venture Capital is a vital component of regional innovation and economic development. *'venture capital (VC) programmes are catalysts for the economic development at Silicon Valley'* (Wonglimpiyarat 2006).

(iv) Western Investment Fund

Set up and run by the Western Development Commission this Venture Capital Business Fund provides loans and equity to high growth enterprises. It has already funded projects in areas such as biotechnology, medical devices, tourism infrastructure and software development. Since 2001 the fund has invested €27 million in 75 SMEs and social enterprises. 72% of these enterprises are based outside the major urban centres (WDC Commission).

4.3 Economic Analysis of the Region

The next step is to identify dominant industries operating in the BMW region which will help determine a focus for this research. The economic activities of the BMW region need to be identified in order to determine the main clusters operating within the region. When identifying regional clusters it is important to understand which industries export goods and services out of the region. Unfortunately this data can be very hard to obtain due to insufficient data collection. A way to overcome this problem is to use the location quotient (LQ) approach. Hildebrand and Mace (1950) are accredited with developing LQ and the technique has been widely used by economic geographers and regional economists since 1940 (Miller, Gibson, and Wright 1991; Thrall, Fandrich, and Elshaw-Thrall 1995).

Clusters can be identified and 'mapped' by determining the LQ based on employment data. This identifies the industries that employ more workers in the region than the national average for that same industry. The theory behind this is that by employing more workers than the national average the industry is producing more goods and services than the region alone can consume; thus the industries export the excess product out of the region. LQ is determined by calculating the percentage of employment in a four-digit SIC code industry within a specified region to total regional employment.The LQ is simply a measure of the concentration of an industry in a local economy such as the BMW region, relative to the concentration of that industry in a larger economy, like the South & East or Ireland as a whole. This ratio is calculated for all industries to determine whether or not the local economy has a greater share of that industry than expected.

$$LQ = \frac{e_i / e}{E_i / E}$$

ei = local employment in industry
e = total local employment
Ei = reference economy employment in industry
E = total reference area employment

The LQ for the country is 1.0 by definition. If the ratios are exactly the same, the location quotient will be 1. If local ratio is less than the comparison ratio the location

quotient will be less than 1, indicating that the industry may not be as strong locally as it is in the comparison economy. If the LQ is greater than one, it suggests that the local industry is more concentrated locally than in the comparison economy, and that some portion of its production is exported out of the region. These industries are identified as having competitive advantage over other regions and may have further growth potential. Government policy can be developed in order to further develop these competitive industries in the region. Since the 1970s different types of regional clusters have established a strong position in world markets for both traditional products (e.g. Third Italy) and more innovative high tech products (e.g. Silicon Silicon Valley). This has led leading researchers and policy makers to observe that *'today's economic map of the world is dominated by (...) clusters: critical masses -- in one place -- of unusual competitive success in particular field'* (Porter 1998: 78).

LQ portrays a much different story than just employment numbers in a region. *'Industries with high LQ are typically (but not always) export-oriented industries, which is important as they bring money into a region rather than money just circulating within a region (as some service industries such as retail and restaurants do). Industries which have both high LQ and relatively high total job numbers typically form a region's economic base*' (EMSI Resource Library).

The next step is to determine the LQ of the various manufacturing sectors, LQ change (%) from one particular year to another and employment data of each specific sector. This enables the researcher to understand how specific sectors are performing over time.

Table 4.18: *Industrial Local Units 2007 – Total Persons Engaged in the State, BMW and S&E Regions by Industry Class*

Traditional Sectors	BMW	% of total Regional Employment	LQ	S&E	% of total Regional Employment	LQ	State	% of total National Employment	LQ
Food products, beverages, machinery (NACE 15, 29)	16,869	0.256	1.1	38,389	0.228	0.9	55,258	0.236	1.0
Textiles and textile products (NACE 17-18)	1,361	0.020	1.2	2,835	0.016	0.9	4,196	0.017	1.0
Chemicals, Chemical Products and Man-Made Fibres (NACE 24)	3,074	0.046	0.5	20,953	0.124	1.2	24,027	0.102	1.0
Wood and wood products (NACE 20)	3,257	0.049	1.5	4,303	0.025	0.8	7,560	0.032	1.0
Pulp paper and paper products; publishing and printing (NACE 21-22)	2,436	0.037	0.5	16,252	0.096	1.2	18,688	0.079	1.0
Rubber and plastic products (NACE 25)	3,676	0.055	1.3	6,090	0.036	0.8	9,766	0.041	1.0
Other non-metallic mineral products (NACE 26)	4,234	0.064	1.3	7,629	0.045	0.9	11,863	0.050	1.0
Basic and fabricated metal products (NACE 27-28)	4,711	0.071	1.0	12,615	0.075	1.0	17,326	0.074	1.0
Electrical and Optical Equipment (NACE 30-33)	17,700	0.269	1.2	36,059	0.214	0.9	53,759	0.230	1.0
Transport equipment (NACE 34-35)	1,127	0.017	0.5	6,459	0.038	1.2	7,586	0.032	1.0
Other manufacturing n.e.c. (NACE 36-37, 16,19,23)	3,685	0.056	1.0	9,027	0.053	1.0	12,712	0.054	1.0
Other (10-14,40-41)	3,640	0.055	1.2	7,334	0.043	0.9	10,974	0.046	1.0
Total	**65,770**			**167,945**			**233,715**		

Source: Census of Industrial Production 2007

Table 4.18 above highlights some concentrated industries in the BMW region such as Food and Beverages, Textiles, Wood and Wood Products, Rubber and Plastic Products, other Non-Metallic Products, Electrical and Optical Products.

The textile industry was a major player in Ireland up until 1995. In 1995 it was Ireland's third largest industry employing 8.9% (9,000 people) of the total manufacturing population. However this industry is very cost sensitive requiring low skilled workers therefore a lot of the production plants moved to lower cost countries.

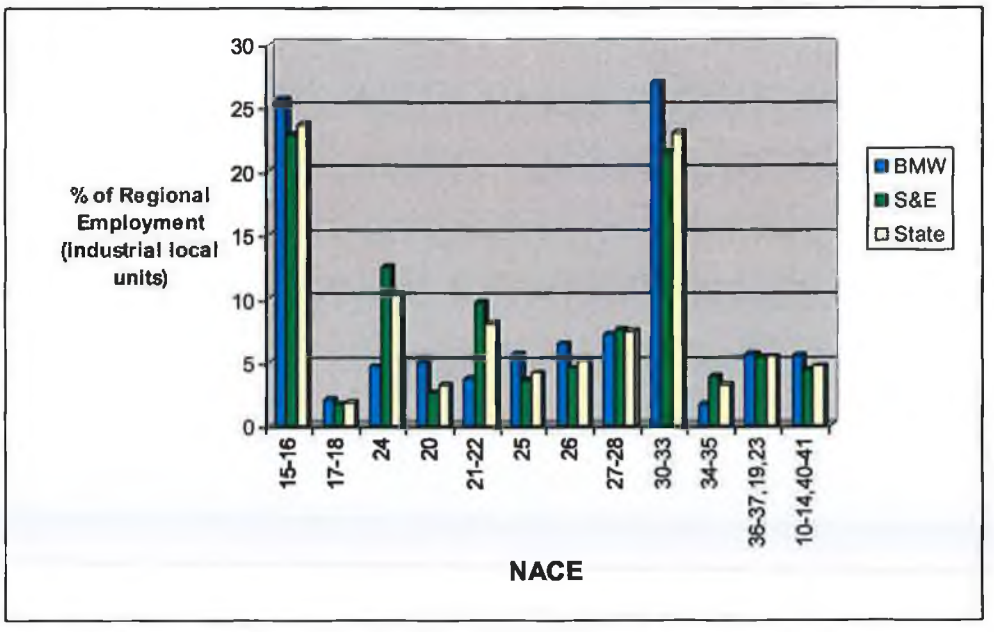

Figure 4.8: *Industrial Local Units 2006 – Total Persons Engaged in the State, BMW and S&E Regions by Industry Class*

Source: Census of Industrial Production 2006

Figure 4.8 above calculates the percentage of regional employment from the employment in industrial local units. This focus at employment data in all manufacturing industries in the BMW region, the South and East region and all of Ireland. It highlights that the Electrical and Optical industry has high employment numbers especially in the BMW region.

Table 4.19 below looks at the LQ change form 2002-2007. The Electrical and Optical Industry has become more concentrated over the last five years.

Table 4.19: *Location Quotient in the BMW region by Industry Class*

Traditional Sectors	LQ 2002	LQ 2007
Food products, beverages and tobacco	1.1	1.1*
Textiles and textile products	1.4	1.2
Chemicals, Chemical Products and Man-Made Fibres	0.7	0.5
Wood and wood products	1.6	1.5
Pulp paper and paper products; publishing and printing	0.5	0.5
Rubber and plastic products	1.5	1.3
Other non-metallic mineral products	1	1.3
Basic and fabricated metal products	0.9	1.0
Electrical and Optical Equipment	1.1	1.2
Transport equipment	0.6	0.5
Other manufacturing n.e.c.	1.8	1.0**

*** manufacturing of food & beverages, manufacturing of machinery & equipment, not incl tobacco / **incl tobacco**
Source: Census of Industrial Production 2006

After working out the LQ for each sector, along with the % change in LQ from 2004 to 2007, the clusters can now be sorted into four groups according to a method developed by the Boston Consulting Group.[5]. These four groups are:

1. "Stars" – Clusters that are relatively specialized (LQ>1) compared to the national economy and are becoming even more specialised over time

2. "Emerging" – Clusters that are relatively unspecialised (LQ<1) compared to the national economy but are becoming more specialised over time

3. "Mature" – Clusters that are relatively specialised (LQ>1) compared to the national economy but are becoming less specialised over time

4. "Transforming" – Clusters that are relatively unspecialised (LQ<1) compared to the national economy and are becoming even less specialised over time.

The aim is to now look at manufacturing industries in the BMW region more closely. To do this employment numbers, location quotient and percentage changes in location quotient were chosen. The vertical axis has the basic LQ measurement for the latest year (2007), whilst the horizontal axis shows the percentage change in LQ over time (2002-2007). Industries are plotted as circles (or bubbles) with the circle size corresponding to their relative size in jobs.

[5] In the 1970s, the Boston Consulting Group (BCG) developed a simple conceptual framework named the Growth-Share Matrix that had a significant impact on business thinking. It is one of the best known and persistent tools in strategic management. This matrix has proven highly adapTable to uses such as initial cluster analysis and assessment.

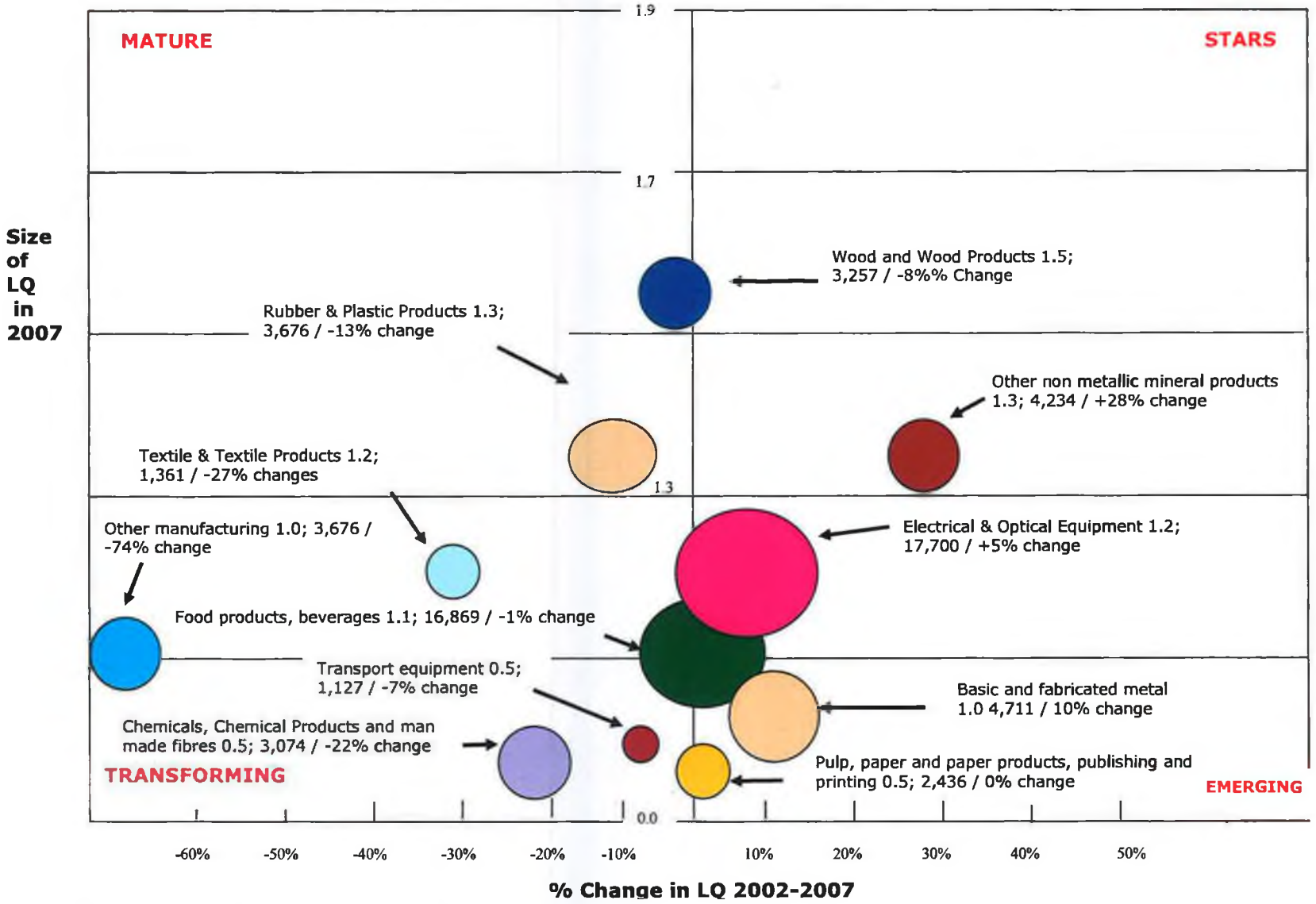

***Figure 4.9**: Industry Clusters and LQ in the BMW Region*
Source: Census of Industrial Production 2006

- "Stars": Upper right hand quadrant contains industries that are emerging, high potential regional export industries that should be developed further: There are no particular industries located in the upper quadrant. However the wood and wood product industry is more concentrated in the BMW region than the national average.
  In the 2006 Census, there were 128 local firms in the Wood Industry (53 of these companies export, majority of this being to the UK) employing 3,224 people in 2006 (CSO). The LQ in this sector stayed the same during 2002-2006 therefore this industry in the region has not been developed further and may even decline over time.

- "Emerging": The lower right quadrant contains industries which are not yet as concentrated in the region as they are at national level. They are however becoming concentrated over time. –
  - In the Electrical and Optical Industry, there are 99 local firms (83 of these companies export, the majority of these to the EU) employing 18,308 people in 2006 (CSO). The LQ in this sector increased from 2002-2006.
  - Other Non Metallic Mineral Product Industry's and Basic and Fabricated Metal Industry's are also becoming concentrated in the region.
  - Non-Metallic Mineral Product Industry's are also quite strong in the region with 118 local firms (49 of these companies export, majority of this to the UK). These industries were employing 3,739 people in 2006 and LQ increased by 20% since 2002 (CSO). These industries have the potential to move across the horizontal axis into the upper right-hand quadrant and therefore could be called pre-emergent industries.

- "Mature": Upper left hand quadrant contains industries that are more concentrated in the BMW region than average but whose concentration is declining.
  - The Rubber & Plastic Product Industry features in this category. In the Rubber and Plastics Industry there were 94 local firms (62 of these companies export, the majority of this to the EU and UK), employing 4,004 people in 2006 (CSO). However the LQ in this sector has declined since 2002.

- "Transforming": The lower left hand quadrant contains industries not concentrated in the region and whose concentration is declining over time.
  - The Chemical, Chemical Products and Man Made Fibres is a declining industry in the BMW region as is other manufacturing (e.g. furniture, jewellery, toys, recycling of waste metal etc).

Therefore after analysing the various industrial sectors in the BMW region the Electrical and Optical Industry has been chosen for a large emerging cluster in the BMW region based on LQ, LQ % change over time and employment numbers. The Electrical and Optical Industry is made up of many different industries such as transport manufacturing, process manufacturing, electronic components, medical devices to consumer goods, this will be further broken down into one specific industry.

4.3.1 Employment in key sectors in the BMW region

In order to analyse the Electrical and Optical Equipment (biomedical sector incorporated into electrical and optical equipment) a study undertaken by the Western Development Commission will be used. This study highlights the emerging biomedical cluster in the BMW region. Biomedical sector is composed of pharmaceutical, biotech, medical device and diagnostic segments.

Table 4.20 below highlights the total employment in each key sector (key sector chosen by BMW regional policy makers) in the regions throughout Ireland. The biomedical industry in the BMW region has the largest concentration with 12,300 people being directly employed in this industry. What is interesting here and helps to justify an emerging cluster is that 8,300 people are directly employed in the western region of the BMW region.

Table 4.20: *Total employment and employees in each of the key sectors by region, 2004*

Area	Employment and Employees in Key Sectors, 2004 (000s)						
	Total Employment	ICT Hardware	ICT Software	Biomedical	Engring	Intl Services	Total Key Sectors
State	**1,757**	**26.6**	**35.8**	**34.9**	**44.9**	**44.4**	**186.5**
Border Midlands and West	**433**	**3.6**	**3.9**	**12.3**	**11.8**	**7.1**	**38.7**
Border	175	1.5	0.6	2.4	4.6	3.6	12.7
Midlands	92	0.7	0.8	1.4	2.4	1.4	6.8
West	166	1.4	2.6	8.3	4.7	2.2	19.2
Dublin & Mid East	**761**	**13.1**	**25.4**	**9.2**	**11.0**	**26.8**	**85.5**
Dublin	616		23.1	5.6	7.8	25.7	67.7
Rest of State	**564**	**9.8**	**6.5**	**13.5**	**22.1**	**10.5**	**62.4**
Mid West	146	4.8	1.9	2.1	6.8	3.9	19.5
South West	246	4.6	2.9	6.9	7.2	5.4	27.1

Note: Totals may not add up due to rounding

Source: Audit of Innovation in BMW Region (Census 2002, CSO, Forfas, ESRI, PACEC)

Table 4.21 below again reiterates that 69% of all employees in the BMW region are working in the biomedical sector

Table 4.21: *Proportion of Total Employment, and of Employees in the Key Sectors, Accounted for by each Region, 2004*

Area	Employment and Employees in Key Sectors, 2004 (%)						
	Total Employment	ICT Hardware	ICT Software	Biomedical	Engring	Intl Services	Total Key Sectors
State	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Border Midlands and West	**25**	**14**	**11**	**69**	**26**	**16**	**21**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Midlands	5	3	2	8	5	3	4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dublin & Mid East	**43**	**49**	**71**	**54**	**24**	**60**	**46**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36
Mid East	8	28	6	21	7	2	10
Rest of State	**32**	**37**	**18**	**77**	**49**	**24**	**33**
Mid West	8	18	5	12	15	9	10
South East	10	2	5	25	18	3	8
South West	14	17	8	40	16	12	15

Note: Totals may not add up due to rounding
Source: Audit of Innovation in BMW Region (Census 2002, CSO, Forfas, ESRI, PACEC)

In Table 4.22 below, the location quotient (LQ) is used. Again the strong concentration of the Biomedical sector in the BMW Region is prevalent particularly in the Western Region.

Table 4.22: The Relative Concentration of Regional Employment (Location Quotient) in the Key Sectors, 2004

Area	The Relative Concentration of Regional Employment (Location Quotient) in the Key Sectors, 2004 (000s)						
	Total Employment	ICT Hardware	ICT Software	Biomedical	Engring	Intl Services	Total Key Sectors
State	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Border Midlands and West	**1.00**	**0.55**	**0.45**	**2.80**	**1.07**	**0.65**	**0.84**
					1.04	0.81	0.68
Midlands	1.00	0.51	0.40	1.58	1.04	0.60	0.69
West	1.00	0.55	0.76	5.00	1.12	0.52	1.09
Dublin & Mid East	**1.00**	**1.14**	**1.64**	**1.24**	**0.57**	**1.39**	**1.06**
Dublin	1.00	0.60	1.84	0.92	0.49	1.65	1.04
Mid East	1.00	3.47	0.78	2.60	0.87	0.28	1.16
Rest of State	**1.00**	**1.16**	**0.56**	**2.24**	**1.53**	**0.74**	**1.04**
Mid West	1.00	2.16	0.64	1.48	1.81	1.07	1.26
South East	1.00	0.18	0.48	2.56	1.85	0.26	0.86
South West	1.00	1.24	0.57	2.87	1.15	0.87	1.04

Source: Audit of Innovation in BMW Region (Census 2002, CSO, Forfas, ESRI, PACEC)

Table 4.23 below, highlights that the biomedical sector naturally has had an employment increase of 96% during the period (2002-2006). The West once again had 158% increase during that particular period.

International Services in the BMW region also had 189% increase in the region. However the LQ for this industry is just 0.65% therefore the concentration is lower than in other regions, Dublin having the largest LQ in this sector.

Table 4.23: Employment changes in key sectors by region, 1996 – 2004

Area	Changes in Employment (%)						
	Total Employment	ICT Hardware	ICT Software	Biomedical	Engring	Intl Services	Total Key Sectors
State	**36**	**1**	**138**	**169**	**-5**	**157**	**49**
Border Midlands and West	**32**	**-11**	**145**	**96**	**-6**	**189**	**38**
Midlands	27	18	58	-32	22	245	45
Dublin & Mid East	**44**	**10**	**121**	**160**	**-5**	**166**	**71**
Mid East	58	39	250	274	-9	68	56
Rest of State	**29**	**-3**	**231**	**225**	**-5**	**121**	**33**
South East	32	-74	974	1117	-5	112	25
South West	28	10	173	506	5	219	64

Note: Totals may not add up due to rounding

Sources: (Census, 2002, CSO, Foras, ESR, PACE)

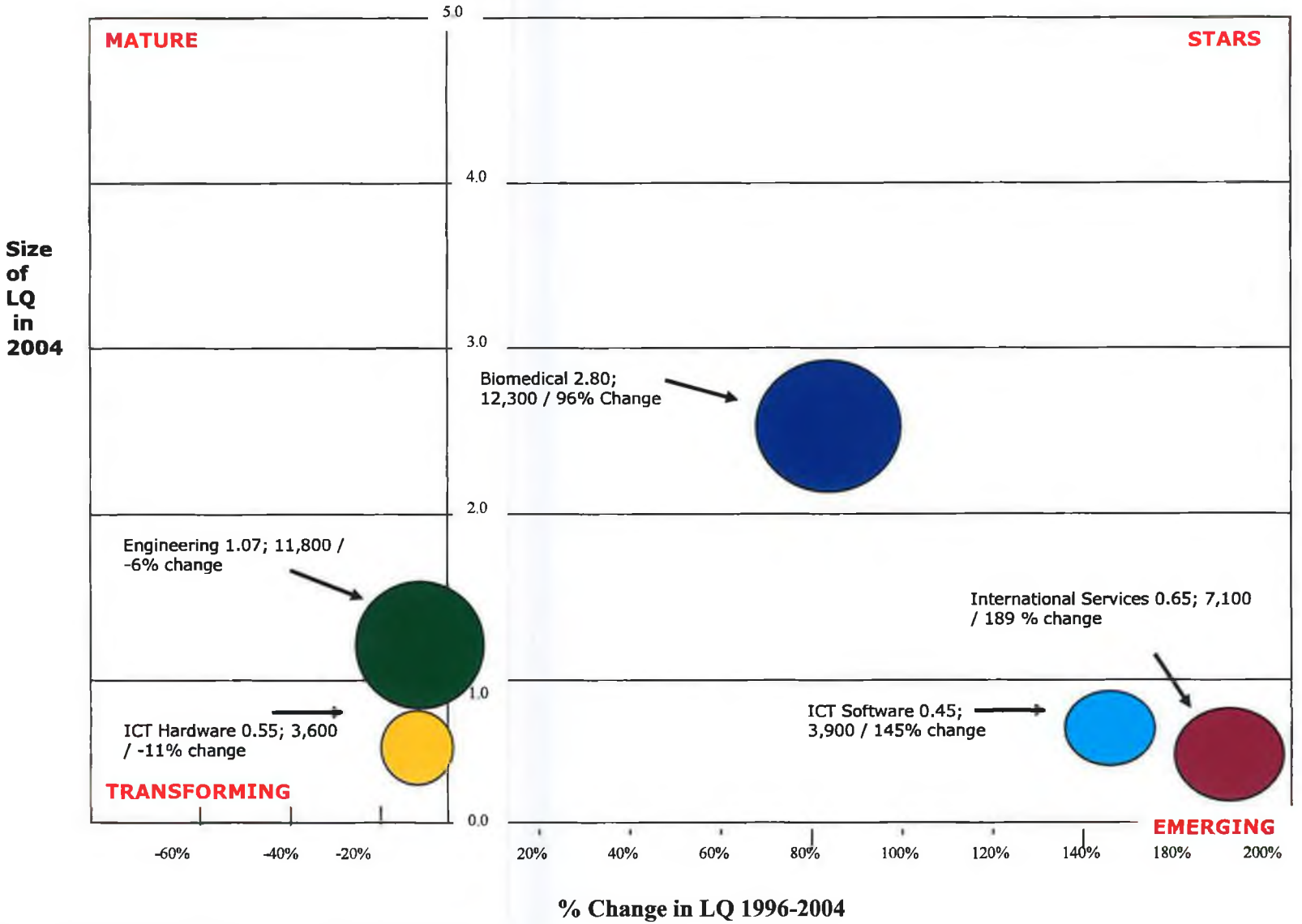

***Figure 4.10**: Industry Clusters and LQ in the BMW Region*
Source: Census of Industrial Production 2006

4.3.1.1 Biomedical Industry in BMW region of Ireland

Since the 1960s Ireland has developed a significant life sciences industry. There are 52,000 people employed directly, or indirectly, in the life sciences industry in Ireland. The total life sciences exports in 2012 was valued at €56.8 bn, accounting for over 63% of total exports, or 35.5% of the GDP (Irish Exporters Association Website, Jan 2012) The most active life science segments in Ireland are medical devices, biotechnology, drug delivery and nutraceuticals. These industries have chosen Ireland as a location for developing and manufacturing their products. The large scale medical devices industries in Ireland are in the relatively high growth and high value-added activities such as the manufacture of medical and surgical instruments, and surgical appliances and supplies.

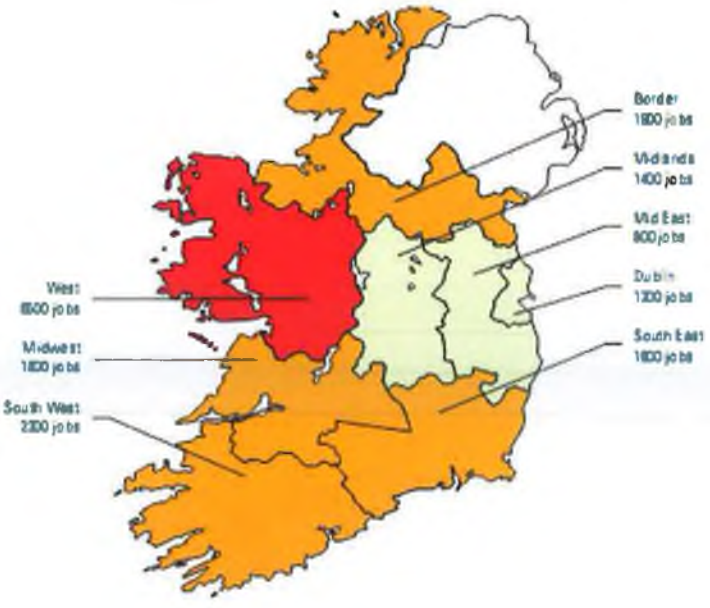

Figure 4.11: *Medical Devices: Employees by Region 2004*
Source: Forfás, PACEC

Ireland is currently home to 15 of the top 20 medical technology companies in the world (the majority of these are operating in the west of the country) and nine of the top ten global pharmaceutical companies are located in Ireland. The Western region accounts for 8,300 jobs or 47% of Ireland's total employment in the sector (highlighted in Tables 4.20 and 4.21 above). The BMW region accounts for 69% of employees working within this sector with Dublin and the Mid East accounting for just 54% of its employees working within the sector. The South West also has a high concentration of biomedical

companies as 40% of its total employees working in the biomedical sector (Audit of Innovation in BMW Region, 2004).

In the Lucerna study (2010) conducted by NUIG six high technology clusters were identified in the BMW region. The biotechnology industry once again featured strongly.

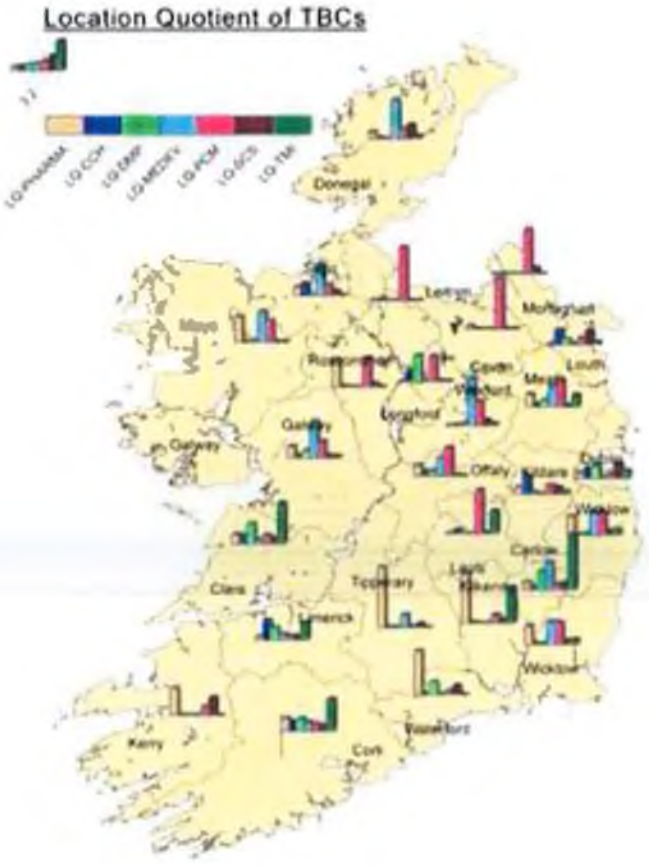

Figure 4.12: *Location Quotient of TBCs*
Source: Lucerna database, CISC, NUIG (2010)

Employment in the Medical Devices sector in the BMW region is concentrated around Galway with almost 40% of employment being in the Western Region, and 31% in Galway City and County. As well as being the leading city of activity by foreign-owned medical device companies, Galway is also the main centre of activity for indigenous

start-up companies and examples include Creganna, Zerusa, Crospon etc. Examples of MNCs in the region include Abbott, Baxter, Boston Scientific, AVE, Allergan and Tyco Healthcare to name a few. The cluster is driven by the presence of two large foreign-owned multinational corporations (MNCs), Boston Scientific and Medtronic, which create most of the employment in the region (employing approximately 4,500 people), over the past ten years there has been a growing indigenous base of smaller-sized companies (Giblin and Ryan 2010). The Irish sector has a comparable scale to the largest clusters globally in Massachusettes and Minnesota. There are various factors which have contributed to this growth and attracted many multinationals to Ireland. *'The initial investments by foreign-owned MNCs (multinational corporations) in the country were predominately low cost assembly manufacturing sites, whereby the corporation was attracted by the low corporate tax rate and special grant aid incentives'* (Lucerna Report 2010: 18). Other factors include full access to the EU and English speaking nation and highly skilled graduates. Over 40% of employees in the medical device and diagnostic sector have third level qualifications (IMDA), contributing largely to the influx of these industries to Ireland.

The presence of these firms has led to the spin out and creation of indigenous based medical industries in Ireland. *'Foreign owned companies account for 90% of employment, however employment in Irish-owned companies is rising faster than employment in foreign-owned companies'* (Forfás and Expert Group on Future Skills Needs 2008)

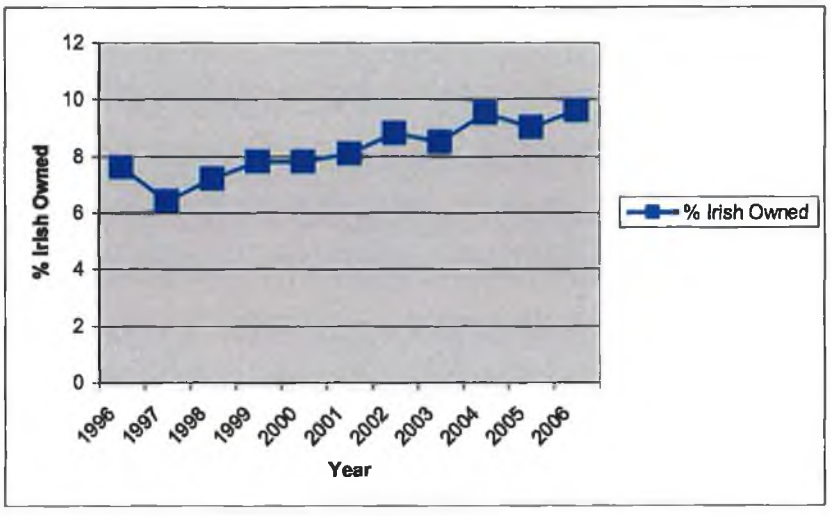

Figure 4.13: *Medical Devices Employment in Ireland by Irish-Owned Companies*
Source: Forfás and Expert Group on Future Skills Needs (2008)

Enterprise Ireland is the state agency that assists many of these indigenous based industries. A number of these companies have become significant international players within the biomedical device sector along with other international biomedical companies based in Ireland. Examples of some of these key players are highlighted in figure 4.14 below.

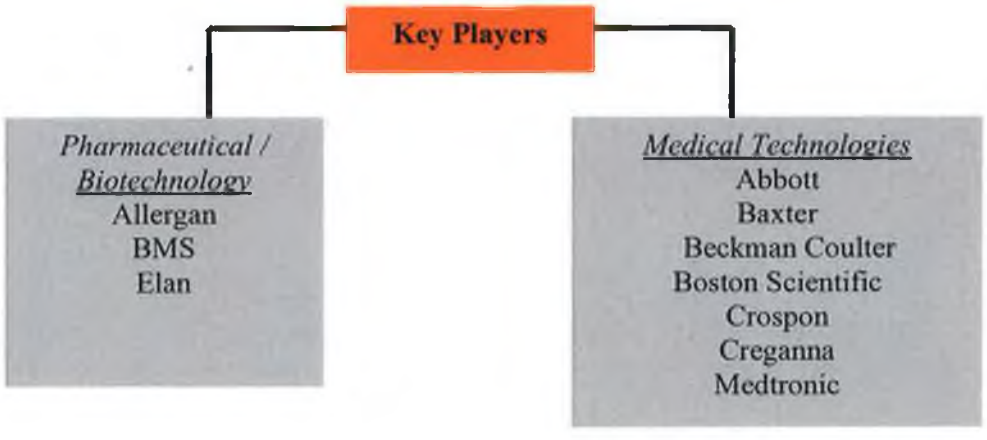

Figure 4.14*: Some of the Biomedical Sector Companies located in the BMW region*

Other key organisations have played and continue to play a key role in the growth and development of this biomedical cluster in the BMW region are:

- The Industrial Development Authority (IDA). Its main task is to encourage multinational companies to locate in Ireland.
- The Irish Medical Devices Association (IMDA), is a business association within IBEC for medical device companies.
- Irish Biotechnology Association (IBA) also affiliated to IBEC.
- Science Foundation Ireland (SFI). SFI invests in academic researchers and research teams who are most likely to generate new knowledge, leading edge technologies and competitive enterprises in the areas of biotechnology, Information and Communications Technology (ICT) and sustainable energy.
- BioMed Ireland (IMDA, IBA, Biobusiness Northern Ireland and Intertrade Ireland – cross border initiative promoting international competitiveness of companies in Northern Ireland and the Republic of Ireland.
- Atlantic Technology Corridor (ICT and Medical Device Association in the western counties (Galway, Clare and Limerick).
- American Chamber of Commerce

The BMW region, with a population of over one million, is home to relevant centres of excellence based at NUIG, GMIT, AIT and Sligo IT. These centres of excellence include bioengineering, polymer technology, laser applications, tool-making and information technology highlighted in the previous section under Knowledge Infrastructure. Figure 4.15 below highlights that a lot of biomedical companies in Ireland are involved in research and development (both indigenous and multinational companies).

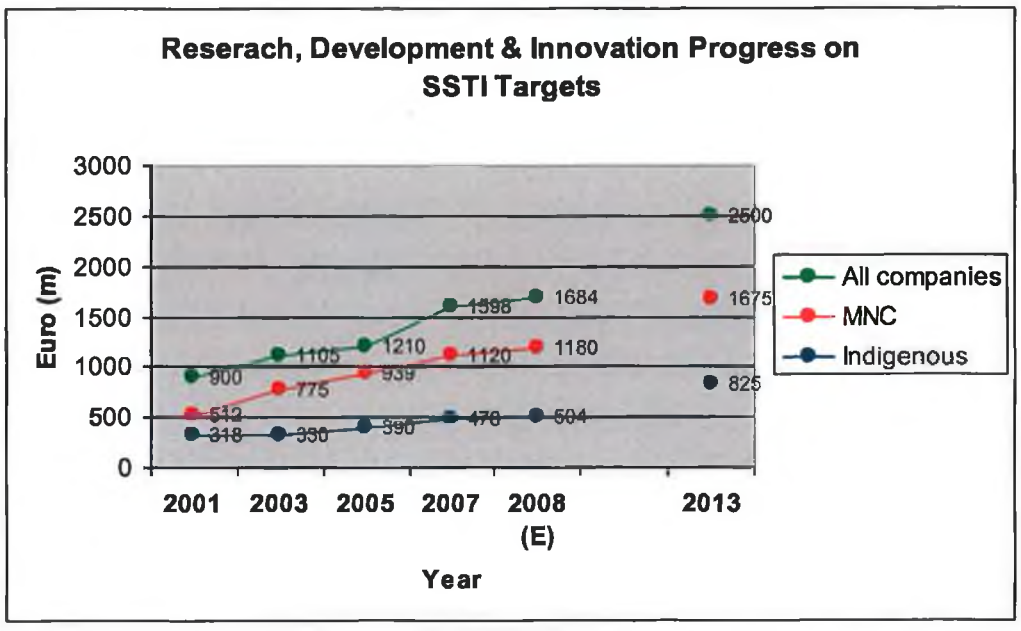

Figure 4.15: *Research, Development & Innovation Progress on SSTI Targets*
Source: IDA

4.4 Summary & Conclusion

This chapter has presented a detailed profile of the BMW region from the perspective of factors that underpin industrial clusters and regional innovation systems have been discussed. Factors such as inadequacies in the physical infrastructure, broadband capability, strong innovation and R&D base, good facilities such as incubation centres and centres of excellence and a good educational base helping to develop the skills base within the region. The regional support infrastructure has been discussed and the important amenities in the region have been highlighted. All the important success factors that stimulate cluster and RIS development are found in the region. An economic analysis of the region has also highlighted the emerging biomedical cluster within the region.

With knowledge now the fundamental basis of competitive advantage, regional economic development agencies are looking for ways to grow and attract clusters of innovative, knowledge-based activity. Research has generally been carried out in urban areas with high population densities and high levels of industrialisation as these regions

are more naturally equipped with relevant actors, knowledge and support agencies, specialised resources skills and competencies (Cooke 2002, Asheim & Gertler 2005).
A key question in this research is to explore whether peripheral regions can also be successful in implementing the RIS framework? Montana (2001) states that all regional policy makers must see the importance of building capacity for continuous reinvention and must explore how this is to be achieved as no community (urban or rural) is immune from effects of the global marketplace.

The chapter has highlighted the various challenges and opportunities that currently exist in the BMW region.
The next chapter presents the findings and explores these factors understanding in more detail the inhibitive and conducive factors which impact on innovation within biomedical companies within the region.

CHAPTER FIVE: FINDINGS

5.1 Introduction

The purpose of this chapter is to report the research findings and to answer the stated question which is:

> *To elicit and evaluate manager's perceptions in selected biomedical industries and supporting institutions on factors conducive to the innovation activity and the development of a RIS in the BMW region.*

This chapter presents the quantitative and qualitative research findings based on an analysis of the data. The interpretive results will address the primary and secondary objectives as set out in chapter three and further discussion on the findings will be provided in chapter five. The data is obtained using a postal questionnaire and follow up interviews (see appendix B).

5.2 Background Information

Valid responses were received from thirty four biomedical firms in the BMW region. In summary questionnaires were administered to ninety six biomedical firms with forty five responding. From the forty five responses received, eleven companies were excluded (two had ceased to operate, two had incomplete information and seven carried out no innovation or R&D), providing a 36% response rate.

This section will provide a general profile of the surveyed population such as:

- Basic characteristics of firms
  - Levels of innovation
  - Ownership of firms
  - Employee numbers
  - R&D activities
- Networks

- Relationships with suppliers
- Relationships with customers
- Relationships with related firms
- Relationships with agencies and institutions
- Relationships with specialist expertise in the region

- Markets & Strategies
  - Export markets
  - Characteristics of competition
  - Sustaining competitive advantage
  - Achieving future competitive advantage

5.2.1 Basic Characteristics

This section will look at characteristics of firms such as levels of innovation, ownership of firms, employee numbers and R&D activities. Overall innovation ranks quite strongly among biomedical companies in the BMW region, reflecting the importance of R&D in the biomedical sector.

5.2.1.1 Levels of innovation

Of the 34 responses, 79% (27) of respondents are involved **product innovation** and 21% (7) of respondents are involved in **process innovation**. It is important to note that most product innovators also introduced process innovations during the same period. Figure 5.1 illustrates these results below:

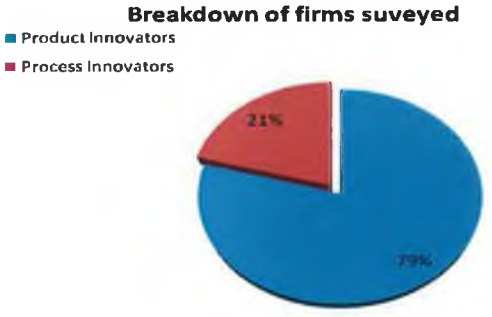

Figure 5.1: *Breakdown of biomedical firms surveyed by category (highlighting main innovation activity undertaken)*

Overall innovation ranks quite strongly among biomedical companies in the BMW region, reflecting the importance of R&D in the biomedical sector.

5.2.1.2 Ownership of firms

As Table 5.1 below depicts, 48% (13) of **Product Innovators** were Irish-owned companies with 52% (14) foreign-owned companies. This highlights the large amount of Irish indigenous companies undertaking product innovation in the region.
Process Innovators were all foreign owned companies (100%).

Table 5.1*: Biomedical firms by ownership and year of establishment*

	Product Innovators	Process Innovators
Irish owned	48%	0%
Foreign owned	52%	100%
Averageestablished company	1994	1976

5.2.1.3 Employee numbers

'One of the factors traditionally considered to be a very important determinant of firms' innovation activities is size, often measured by employee numbers' (Kautonen, 2006:92). Figure 5.2 below illustrates employee numbers by innovation categorisation.

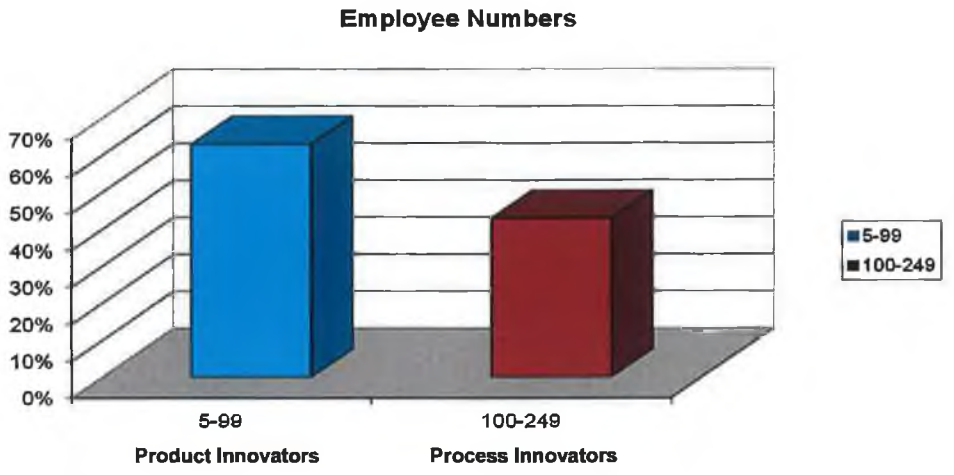

Figure 5.2: *Employee numbers by innovation categorisation*

In the **Product Innovator** category, 63% (17) of respondents employ 5-99 employees. As McKelvey (2001) argues, smaller firms are often able to commercialise radical innovations more quickly than larger established companies. Firms employing 500+ people are also heavily involved in product innovation whilst also undertaking ongoing process innovation. From the firms surveyed, 22% (6) of Product Innovators have over 500 staff employed.

In the **Process Innovator** category, firms have larger employee numbers than Product Innovators. From the respondents, 43% (3) of Process Innovators employ 100-249 people, reflecting that all these firms are multinational companies.

5.2.1.4 R&D activities

Respondents were asked if their company had its own R&D activities during the period covered by the research.

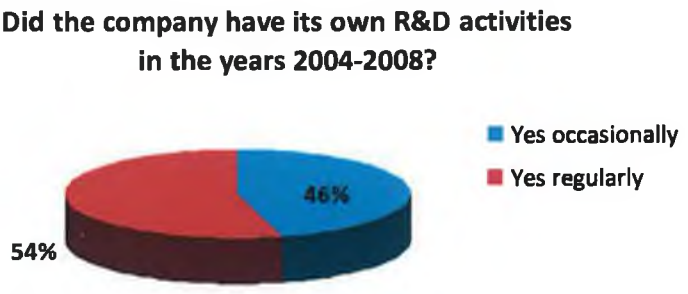

Figure 5.3: *R&D activities 2004-2008*

Figure 5.3 above depicts that all respondent companies have R&D taking place. Of the 34 responses, 54% (19) of firms have R&D taking place on a regular basis, with 46% (16) of firms engaging in R&D occasionally (on single development projects). This highlights the importance of R&D and innovation for the biomedical industry.

Respondents were then asked the average R&D spend during the period. Figure 5.4 below illustrates R&D spend by innovation categorisation.

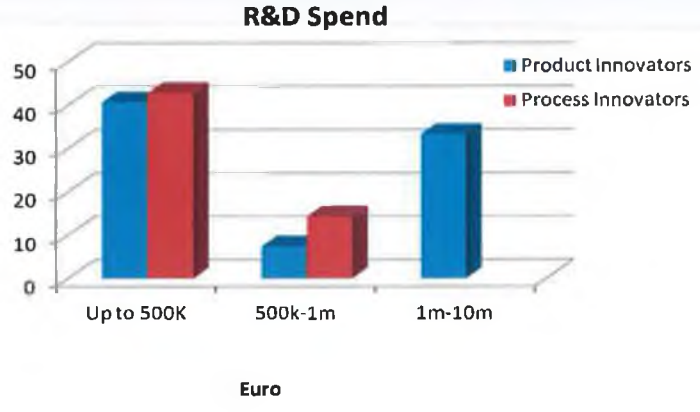

Figure 5.4: *General overview of biomedical firms R&D spend (%) by innovation categorisation in the BMW region from 2004-2008*

Forty one percent (11) of respondents in the **Product Innovator** category have spent up to €500k on R&D, 7% (2) have spent between €500k-€1m on R&D and 33% (9) have

spent between €1m-€10m on R&D. The majority of Product Innovators have spent up to €500k on R&D during the period.

Forty three percent (3) of respondents in the **Process Innovator** catogory have spent up to €500k, 14% (1) have spent from €500k-€1m and no respondents spent over €1m in the Process Innovator category.

Figure 5.5 below further breaks down the R&D spend into smaller categories.

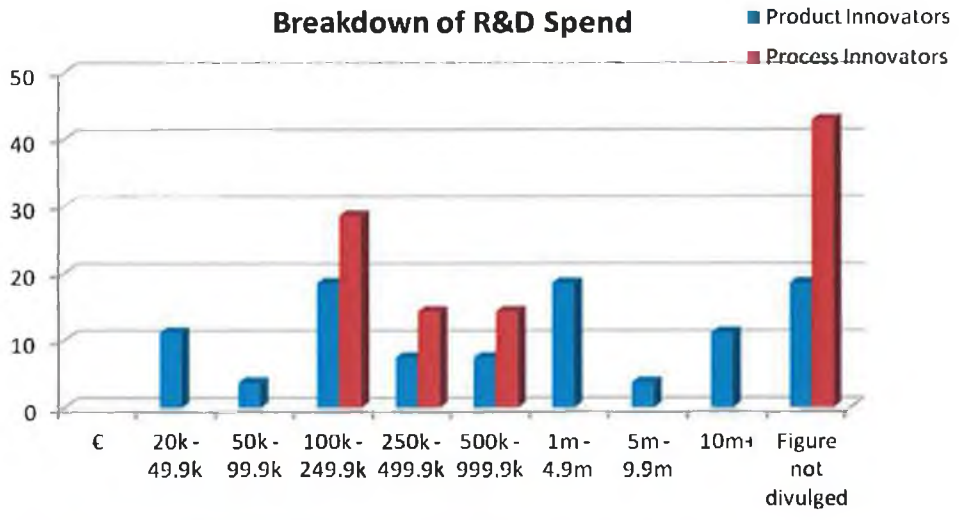

Figure 5.5: *Breakdown of biomedical firms R&D spend (%) by innovation categorisation in the BMW region from 2004-2008*

R&D spend by **Product Innovators** varies between companies. Nineteen percent (5) of Product Innovators spend between €100k- €249.9k with another 19 (5) spending between €1m-€4.9m.

Table 5.2 below profiles Product Innovators with the largest R&D spends.

Those spending between €100k and €249.9k are a mixture of MNCs and Irish owned companies and employ between 1-4 full-time staff in R&D with 0-3 part-time staff working in R&D. Those spending between €1m and €4.9m are mostly MNCs and employ between 8-20 full-time staff in R&D and 2-6 part-time staff in R&D.

Table 5.2: *Breakdown of largest R&D spends by Product Innovator*

R&D Spend	Ownership	Staff (FT)	Staff (PT)
€100-€249.9	3 MNCs / 2 Irish	1-4	0-3
€1m-€4.9m	4 MNCs / 1 Irish	8-20	2-6

Process Innovators have lower R&D costs. Table 5.3 below depicts characteristics of Process Innovators with largest R&D spends.

They spend on average between €100k and €249.9k, all are MNCs and employ 2-4 full-time staff and 1-3 part-time staff. Forty three percent (3) of respondents were not prepared to divulge R&D spend from 2004-2008.

Table 5.3*: Breakdown of largest R&D spends by Process Innovator5*

R&D Spend	Ownership	Staff (FT)	Staff (PT)
€100-€249.9	2 MNCs	2-4	1-3

5.2.2 Networks

This section analyses related external interactions of respondent firms within the region. It explores collaborative relationships with suppliers, customers and related firms. As discussed in previous chapters, customers and suppliers are at the core of a RIS. The needs and wants of customers and suppliers drive the market for new services and products and are usually seen to have a major impact on the development of a RIS.

The main goal of collaborative relationships is to gain access to new and complementary knowledge, giving rise to greater efficiencies. Firms can acquire new knowledge from the external environment by activating processes of external learning (Malerba, 1992), such as learning by imitation and by interaction and establishing more or less structured and formalised network relationships (Nooteboom, 2000)

Cooperative relationships with agencies and institutions is also analysed along with the use of specialist expertise in region

The results are depicted in Table 5.4 below:

Table 5.4: *Origins of industries and origins of purchases, sales and competitors by innovation categories (%), blue indicating highest in the row*

Business Activities	*Number of Firms (N)*	*Product Innovators*	*Process Innovators*
Business Headquartered	*34*	27	7
In Region		**63%**	0%
[illegible]		[illegible]	[illegible]
Outside Ireland		33%	**100%**
Main Competitors Located	*34*	27	7
In Region		4%	0%
Elsewhere in Ireland		30%	0%
Outside Ireland		**96%**	**100%**
Main Customers Located	*34*	27	7
In Region		22%	29%
Elsewhere in Ireland		[illegible]	[illegible]
Outside Ireland		**78%**	**71%**
Company Purchase from	*34*	27	7
In Region		56%	57%
Elsewhere in Ireland		44%	71%
Outside Ireland		**85%**	**86%**

5.2.2.1 Relationships with Suppliers

Over 50% of all respondents purchase within the region, therefore availability of suppliers to biomedical firms in the region is quite good. One **Process Innovator** stated that *'We have a pretty uncomplicated supply chain, we have a lot of secondary suppliers located here but our primary supplier, the one who supplies the wire, is an American company located here'*. Firms were also asked about their opinions in relation to the quality of the regional suppliers. Of the 34 responses, 43% (15) consider the quality of the regions suppliers as being 'good' or 'very good'.

5.2.2.2 Relationships with Customers

Biomedical firms in each category indicate that customers are mainly based outside of the region and Ireland also. Less than 30% of respondents in each innovation category have customers located within the region. **Process Innovators** have the largest amount of customers in the region with 29% (2) of respondents (both MNCs) stating they have customers located within the region. MNC's are more likely to have customers located in the region or Ireland. Firms were also asked about their opinions in relation to proximity to customer. Process Innovators (57%) were more likely to state that proximity to customers was 'good' or 'very good' than product Innovators (37%). Of the 34 responses, 46% (16) of respondents consider proximity to customers to be 'good' or 'very good'. Proximity to customers therefore does not seem to be an important locational factor for firms when locating in the BMW region. The majority of respondents (76%) state that they have customers located outside of Ireland. However these customers may still be involved in the innovative process. One **Product Innovator** stated that *'Most ideas come from customers, therefore customers drive innovation... We do not let geographical distances disturb maintaining key customer relationships'*.

5.2.2.3 Relationships with Related Firms

Biomedical firms in each category indicate that related firms or competitors are mostly located outside of Ireland. In the **Product Innovator** category 4% (1) of respondents have related firms based in the region. Firms were also asked about their opinions on the presence of related firms. Of the 34 responses, 57% (20) of respondents believe that the presence of related firms is 'good' or 'very good', and 41% (14) perceive related industries in the region as 'valuable' or 'extremely valuable'. When carrying out the qualitative research a major factor in biomedical firms locating in Ireland was due to the presence of other related firms. One Product Innovator stated: *'The presence of other related firms gives confidence to decision makers when coming to visit the plant here in Galway'*. However it was also established through qualitative research that the lack of interaction between biomedical companies in the region is mainly due to intellectual property (IP) issues in this industry. The Product Innovator explained *'there is limited*

inter firm interaction with companies in the region mainly due to IP issues but related industries can provide an engineering resource such as a transfer of knowledge and employees'. The **Process Innovator** interviewed stated that they would work a lot with other medical device companies in the region. *'We would work with them all really. We do partner in terms of providing solutions. We would have to sell our capabilities and demonstrate that we can deliver on these capabilities. They would come looking for a technical solution which we can provide, they wouldn't necessarily be willing to share IP to provide that solution'*. Therefore relationships between related firms is established when they are providing solutions or transferring staff rather than idea generation and collaboration on projects.

The **Product Innovator** interviewed indicated that related industries can also provide new product ideas for biomedical firms in the region as *'some key manager's spin out of their firm or related industry and set up a small start-up. Larger companies can then look to acquire the new firm if market potential has been proven and the IP is protected with the new product'*. Figure 5.6 below depicts the respondent's views on the importance of relationships for competitiveness.

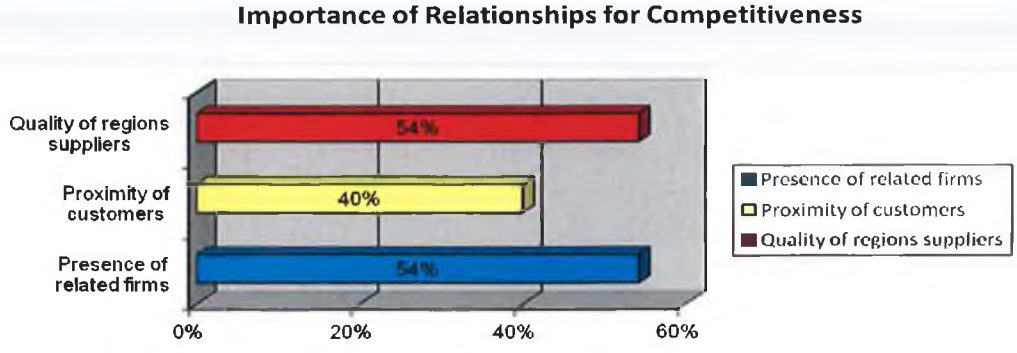

Figure 5.6: *Views of biomedical managers on the importance of relationships for own competitiveness (N=34) (3-5 on Likert Scale of 105)*

Figure 5.6 above reiterates that 54% (19) of all respondents view the quality of the regions suppliers to be 'good' or 'very good' for competitiveness. Proximity to customers is not viewed as important with 40% (14) of respondents stating that proximity to customers is 'good' or 'very good' for competitiveness. Fifty four percent

(19) of respondents viewed presence of related firms to be 'good' or 'very good' for competitiveness. As one Product Innovator stated *'This helps to build confidence and attract more companies into the region'*. As stated previously however competition remains quite low among related firms.

5.2.2.4 Regional Innovation Network

This section of the research will examine the relationships that biomedical firms have with various support agencies and institutions in the region. Respondents were asked to specify the value they place on the Innovation Network currently available in the region. Results are summarised in Table 5.5 below.

Table 5.5: *Characteristics of Innovation Network (1=not valuable 5=Extremely valuable) blue indicating the highest values (3-5 on a Likert Scale of 1-5), yellow indicating the lowest values (1-2 on a Likert Scale of 1-5)*

Level of Support (n=34)	N	Not Valuable	Somewhat Valuable	Valuable	Quite Valuable	Extremely Valuable	N/A
Universities and Colleges	34	9%	32%	24%	15%	18%	3%
Regional Suppliers	34	12%	26%	26%	15%	9%	12%
VC	34	24%	12%	6%	0%	6%	53%
Industry or Cluster Associations	34	6%	15%	29%	24%	9%	18%
Entrepreneurial Networks	34	6%	26%	21%	15%	0%	32%
Business Incubators	34	6%	26%	15%	3%	6%	44%

Of the 34 responses, 62% (21) consider industry or cluster associations as being 'valuable' or 'extremely valuable', of which 20% are Irish companies and 42% are MNCs. Through the qualitative research the American Chamber of Commerce was identified by respondents as playing a major role for multinationals in Ireland in terms of networking.

Fifty six percent (15) of respondents consider Universities and College to be 'valuable' or 'extremely valuable', of which 38% are Irish owned companies. Fifty six percent (15) of respondents consider regional suppliers to be 'valuable' or 'extremely valuable'.

Interestingly Table 5.5 above highlights the lack of risk capital from Venture Capitalists (VCs), 53% (18) indicating VCs to be non applicable with 76% (26) viewing VCs as not valuable or not applicable. 82% of multinational companies view VCs as 'not valuable' to 'non applicable'.

5.2.2.5 Externally sourced expertise

This section summarises the various external expertise that was available to biomedical firms in the BMW region during the period.

In Table 5.6 below, 74% (20) of **Product Innovators** sourced Personnel Training, 48% (13) of Product Innovators sourced external expertise in R&D, Strategic Management and Production. Product Innovators are actively developing their internal capabilities by enhancing qualifications of staff and investing in R&D. This would indicate that firms in this category are proactive in their strategy by focusing on innovation and future strategy.

Table 5.6: *Type of externally sourced expertise acquired by Product Innovators during the last four years 2004-2008, (1=not used, 5=used a lot), blue indicating the highest values (3-5 on a Likert Scale of 1-5), yellow indicating the lowest values*

Externally sourced expertise over last 3 years?		1	2	3	4	5	N/A
Product Innovators (n=27)		Not used				Used a lot	
Management of HR	27	44%	19%	26%	7%		4%
Personnel Training	27	19%	7%	**44%**	**22%**	**7%**	
Sales and Marketing	27	44%	15%	22%	19%		
Partner Search and Networking	27	33%	26%	19%	15%	7%	
Financial Administration and Financing	27	33%	30%	22%	7%	7%	
Information Systems	27	22%	37%	22%	11%	7%	
Production	27	33%	19%	26%	11%	11%	
Research and Development	27	30%	22%	**19%**	**22%**	**7%**	
Strategic Management	27	30%	22%	19%	26%	4%	
Other							

From the 27 Product Innovators, 44% (12) indicated that management of HR and sales and marketing was not outsourced to an external company.

In Table 5.7 below, 86% (6) of **Process Innovators** sourced experts in Personnel Training and 57% (4) in Production. This would indicate that Process Innovators are looking to be more adaptive and seeking greater efficiency.

Table 5.7: *Type of externally sourced expertise acquired by Process Innovators during the last four years 2004-2008, (1=not used, 5=used a lot), blue indicating the highest values (3-5)*

Externally sourced expertise over last 3 years?	*N*	1	2	3	4	5
Process Innovators (n=7)		Not used				Used a lot
Personnel Training	7		14%	57%	14%	14%
Sales and Marketing	7	43%	29%	14%		14%
Partner Search and Networking	7	43%	29%	14%	14%	
Financial Administration and Financing	7	57%	29%	14%		
Information Systems	7	14%	57%	29%		
Production	7	29%	14%		57%	
Research and Development	7	14%	43%	14%	29%	
Strategic Management	7	43%	14%	14%	29%	
Other						

5.2.3 Market &Strategies

5.2.3.1 Export Markets

Figure 5.7 below depicts that the majority (97%) of biomedical firms export except for one company in the Product Innovator category. It is assumed that this company must just supply its products to the biomedical companies here in Ireland.

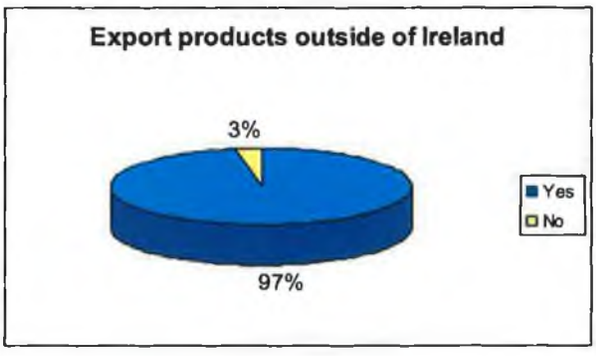

Figure 5.7: *All firms surveyed by export (%)*

5.2.2.2 Characteristics of Competition

This section outlines the broad situation in markets. The first part explores the home market. Twenty nine percent (10) of respondents consider that the level of competition between related industries in the region is 'not good' or 'fair', with 34% (12) of respondents stating that local competition is 'not applicable' to them (these companies are based in export rather than the domestic market). Therefore level of competition between biomedical industries in the region is quite low. This could be due to the lack of collaboration between the industries in the region (due to intellectual property issues) and also the fact that the majority of customers are located outside of Ireland.

Table 5.8 below depicts the respondents own assessments on changes taken place in their main markets and competition in these markets.

Table 5.8: *Changes in markets and competition from 2004-2008 by innovation categories (%)*

	Product Innovators	Process Innovators
Changes in size of Domestic Market	Remained Stable (52%)	Remained Stable (50%)
Changes in size of Foreign Market	Increased (70%)	Remained Stable (67%)
Domestic Competition	Remained Stable (63%)	Increased (57%)
Foreign Competition	Remained Stable (56%)	Increased (57%)

Seventy percent (19) of **Product Innovators** state that opportunities in foreign markets increased during the period 2004-2008. This explains their involvement in innovation and R&D in order to capitalise on this increased market opportunity. Fifty six percent (15) of Product Innovators consider domestic competition to have remained stable and 63% (17) consider foreign competition to have remained stable during the period.

Fifty seven percent (4) of **Process Innovators** consider that foreign competition increased and 57% (4) consider domestic competition increased during the period 2004-2008. This emphasises the competitive pressures coming from both inside and outside the country.

Fifty two percent (14) of **Product Innovators** and 43% (3) **Process Innovators** consider that opportunities in domestic markets largely remained stable.

5.2.2.3 Achieving competitive advantage

All firms have to look at different ways to attain competitive advantage. This maybe achieved by launching new products or services, researching new market opportunities for existing products or collaborating in order to achieve competitive advantage. Greater contact with the market helps stimulates internal development processes in enterprises, as well as demand for new products.

To effectively benefit from R&D investments and improve innovation output, a company needs to develop its internal strategy and define priorities in order to build competitive advantage. These results are summarised in Table 5.9:

Table 5.9: *Changes in functions during the last four years 2004-2008, (1=not much, 5=a lot), blue indicating the highest values (3-5 on a Likert Scale of 1-5)*

Changes in the following functions from 2004-2008	*1*	*2*	*3*	*4*	*5*	N/A N/A
Product Innovators						
Product & Services	7%	11%	41%	33%	7%	
Cooperations with other companies / orgs	7%	15%	44%	22%	11%	
Process Innovators						
Product & Services		14%	43%	43%		
Cooperations with other companies / orgs		43%	43%	14%		

Table 5.9 depicts that 86% (6) of **Process Innovators** and 81% (22) of Product Innovators consider changes to have mainly taken place in the areas of products and services. Seventy eight per cent (21) of Product Innovators also have been developing more cooperations with other companies whilst 74% (20) have considered that focusing on market areas and customers has been a priority. This would reiterate that firms in the Product Innovator category are always interested in developing new products and enhancing market position.

5.2.2.4 Maintaining Future Competitive Advantage

This section investigates how sampled companies plan to maintain future competitive advantage. These responses are summarised in Table 5.10 below:

Table 5.10: *Maintaining Future Competitive Advantage, (1=not much, 5=a lot), blue indicating the highest values (3-5 on a Likert Scale of 1-5)*

Product Innovators (27)		1	2	3	4	5
Maintaining Competitive Advantage	N					
Developing qualifications of personnel	27		4%	30%	52%	15%
Developing marketing	27	4%	15%	15%	33%	33%
Investing in new foreign export markets	27	4%	15%	11%	26%	44%
Developing new products	27			4%	30%	67%
Investing in production automation	27	4%	19%	26%	30%	22%
Cutting down labour costs	27	4%	19%	22%	30%	26%
Focusing on core competences and outsourcing	27		30%	37%	22%	11%
Intensifying relationships with key customers	27		4%	7%	30%	59%
Developing co-operation with research institutions	27	4%	22%	41%	22%	11%
Developing co-operation with important suppliers	27		15%	15%	48%	22%
Increasing co-operation with other firms	27	7%	26%	41%	15%	11%
Developing internal organisation of company	27	4%		30%	44%	22%

Interestingly Product Innovators consider developing new products as the most important way to maintain future competitive advantage going forward.

Figure 5.8 below illustrates the top five results from **Product Innovators** in areas such as developing new products (100%), developing qualifications of personnel (96%), intensifying relationships with key customers (96%), developing internal organisation of company (96%) and increasing cooperation with important suppliers (85%).

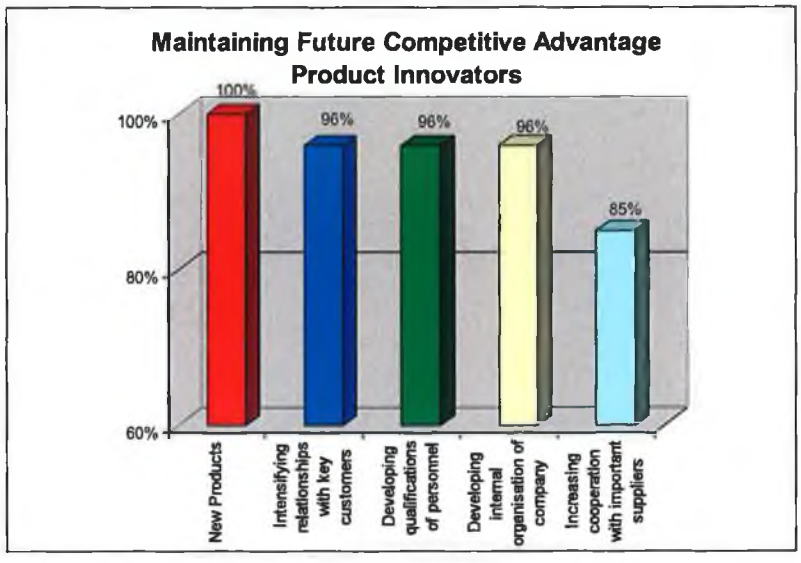

Figure 5.8: *Maintaining Future Competitive Advantage (Product Innovators)*

This finding reiterates the importance of innovation for Product Innovators with 100% (27) of respondents emphasising that new products will be produced.

Interestingly 33% (9) of Product Innovators consider that cooperation with other firms as not being 'important' for future competitive advantage even though they have paid more attention to developing cooperation with other firms over the last four years. Here Table 5.11 below investigates how Process Innovators plan to maintain future competitive advantage.

Table 5.11: *Maintaining Future Competitive Advantage, (1=not much, 5=a lot), blue indicating the highest values (3-5 on a Likert Scale of 1-5)*

Process Innovators (7)		1	2	3	4	5
Sustaining Competitive Advantage	N					
Developing qualifications of personnel	7			43%	57%	
Developing marketing	7	29%		57%	14%	
Investing in new foreign export markets	7	14%	14%	29%	43%	
Developing new products	7			29%	57%	14%
Investing in production automation	7			14%	43%	43%
Cutting down labour costs	7			29%	57%	14%
Focusing on core competencies and outsourcing	7		43%	29%	29%	
Intensifying relationships with key customers	7	14%			43%	43%
Developing co-operation with research institutions	7		29%	29%	29%	14%
Developing co-operation with important suppliers	7		14%	57%	14%	14%
Increasing co-operation with other firms	7	14%	43%	43%		
Developing internal organisation of company	7				86%	14%

Figure 5.9 below illustrates the top four results from **Process Innovators.** These include developing qualifications of personnel (100%) developing new products (100%), investing in product automation (100%) and cutting down on labour costs (100%) as important to extremely important in maintaining future competitive advantage. Areas such as product automation and cutting down on labour costs would highlight that Process Innovators are looking at a lower cost strategy in order to maintain future competitive advantage in the marketplace.

Process Innovators also consider increasing cooperation with other firms as 'not being important' going forward, as 57% (4) believe it is 'not important' or 'somewhat important'. This is in contrast to Product Innovators who believe it to be an important future strategy.

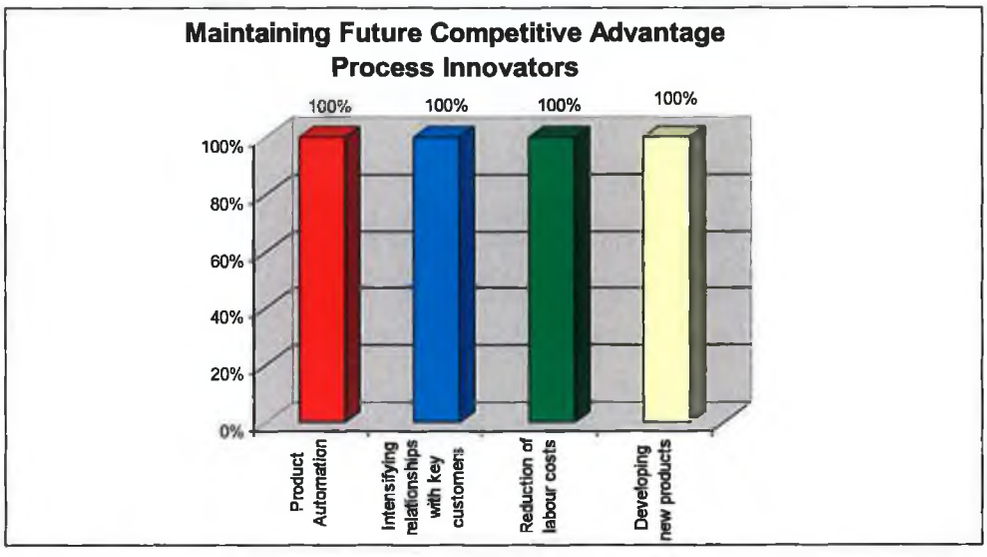

Figure 5.9: *Maintaining Future Competitive Advantage (Process Innovators)*

This section has described the background and characteristics of Product and Process Innovators operating in the BMW region, exploring levels of innovation, ownership of firms, R&D activities, markets and competition and innovation networks. The next section addresses the research question by exploring the factors perceived as conducive on the development of a regional innovation system in a peripheral region.

5.3 Main Findings

This section reports the main findings of this research. In addition to the internal company factors stimulating innovation, the external environmental factors are as important (Porter & Stern 2001). These external factors can be conducive or inhibitive to the innovation activity within firms and therefore to the transformation of growth of a RIS within a region. In this section I will collate responses from biomedical companies surveyed regarding regional factors that have influenced the growth of a regional innovation system in the BMW region.

5.3.1 Factors perceived as conducive for RIS development

Strategic decision makers in biomedical firms in the BMW region were asked to rate the factors they believe as conductive for RIS development. Figure 5.10 below illustrates the top findings, and these findings are then analysed.

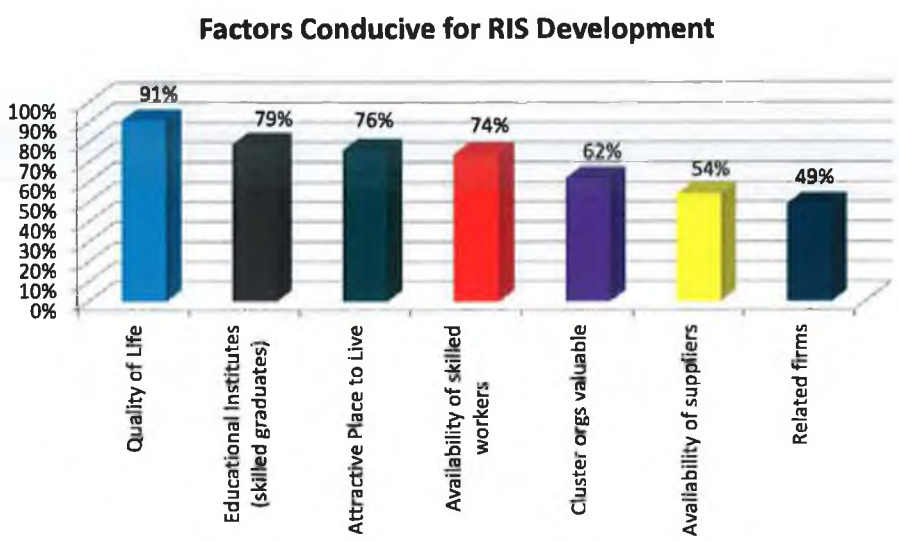

Figure 5.10: *Factors conducive for RIS Development*

5.3.1.1 Quality of life

From the firms surveyed, 91% (31) considered the regions overall quality of life as being 'good' or 'very good' and conducive to the development of a regional innovation system. According to one **Product Innovator**, *'quality of life is a very important aspect of the BMW region'*. This receives the highest rating factor with biomedical firms in the region. According to the IDA representative *'the quality of life is perceived as being good. Property costs are definitely an issue. The quality of local hotels and restaurants is also very important when strategic decision makers come to view the region'*. Eighty percent of respondents also stated that the region was a tolerant and attractive place for people with diverse backgrounds. Quality of life is very important in attracting more people to live and work in the region, in turn attracting more industries and people to the region.

5.3.1.2 Educational Institutes

From the firms surveyed, 79% (27) considered educational institutes to be 'good' or 'very good' in the BMW region. This is the second highest innovation factor rating for firms surveyed in the region. According to one **Product Innovator** *'Universities have evolved their skill set. They now have a strong engineering sector. NUIG did have mechanical engineering which is what I did in college but that has now moved on and they now have biomedical engineering. This helps create graduates at a higher level. Universities and Institutes of Technologies have identified core industries and built courses to service our needs'*. One such centre is the National Centre for Biomedical Engineering Science (NCBES) at NUIG founded in 1999 mainly due to the establishment of medical device companies in the region. A university representative at **NUIG** stated that *'the number of people looking at strategies for innovation and development decided that biomedical engineering was very important for the region, the decision was mainly influenced by the large amount of biomedical industries located in the region. The NCBES is the primary research centre in the university.'* The principle aim or goal of the centre is to conduct research and educate graduates to higher degrees in biomedical engineering. A university representative at **NUIG** stated *'there is a large amount of fundamental research which is basically called discovery research and a lot*

of research that is industry linked. Most of research conducted within the Institute would be industry linked research.'

5.3.1.3 Availability of skilled workers

From the firms surveyed, 74% (25) considered the availability of skilled workers in the region as 'good' or 'very good'. This is the third highest innovation factor rating for firms surveyed in the region. This is undoubtedly reflected in the quality of graduates being produced by the Colleges for this sector. According to a representative at **NUIG,** the College has now put on courses to service the needs of biomedical industries in the region. *'We now have a Masters in Regenerative Medicine and a Masters in Biomedical Engineering (by distance learning which is specifically for industry). Our job is to be responsive to the needs of industry'.* A representative from **Enterprise Ireland** also highlighted a new Masters in Electronics (combines electronic engineering and business) which NUIG are currently piloting. From the qualitative interviews, various initiatives were mentioned such as the Science and Technology Festivals that take place each year which biomedical firms support, also Internship Programmes and summer work experience all hoping to encourage younger people to explore biomedical science as a future career.

5.3.1.4 Cluster organisations

From the firms surveyed, 62% (21) considered cluster organisations to be 'valuable' or 'extremely valuable' and 54% considered that business leaders proactively share information and resources where possible. Networking in the region has mainly been conducted through Enterprise Ireland (for Irish companies), IDA and American Chamber of Commerce (for multinational companies) and the IMDA. Due to various organisations representing different interest groups this once again reiterates the lack of interaction between indigenous industries and multinationals. A key point made by a representative from **Enterprise Ireland** was that '*critical mass is the key to this and therefore perhaps we need to look nationally instead of regionally for networking especially targeting specific sectors, as Ireland is too small'.*

Another important comment from a representative from **NUIG** is the lack of interaction between NUIG and other Institutes in the region *'There is a lack of interaction with all colleges in the BMW region and this is something needs to be developed'*. In particular NUIG and GMIT need to look at working together to promote what each facility can offer the biomedical industry in the region going forward.

5.3.1.5 Regions suppliers

From the firms surveyed, 54% consider regional suppliers to be 'valuable' or 'extremely valuable'. Multinational companies surveyed were more likely to purchase from local suppliers in the region than Irish based companies. From the **Product Innovator** interviewed, he stated that *'non specialised materials would often be purchased locally, companies may have to go outside of region to obtain more specialised materials, depending on what is needed'*.

5.3.1.6 Presence of Related Firms & spin offs

As the BMW region is now home to many major biomedical companies such as Boston Scientific, Medtronic, Abbot and Tyco Healthcare many more industries have been attracted to set up near, or in close proximity, to these firms. The establishment of these major industries gives credibility and confidence to the region as results indicate that 49% of firms surveyed considered related firms to be 'valuable' or 'extremely valuable'. These firms facilitate others '*firms in participating in international networks through the positive reputational effects that the cluster can create* (Giblin and Ryan, 2010).

A representative from one of the agencies stated *'sharing of knowledge is not the main outcome from related firms being based in the region but rather the attraction of established firms gives credibility and confidence to the region and attracts related firms into the region'*. This in turn creates spin offs from established businesses. From the firms surveyed, 37% considered that successful business people in the region invest in economic development projects and start-ups in the region. That is something that is often mentioned. One **Product Innovator** stated *'entrepreneurial spin outs is something that is common within the medical device industry, more often these are then bought up by multinational companies, we have had one such incidence of that occurring here'*.

This can be quite beneficial for multinational or larger indigenous industries who can then buy the technology when it is tried and tested by the start-up company. The connections and networks that these individuals have established during their time working for the company can benefit them in their new business venture.

5.3.1.7 Culture

The culture of a region and regional attitudes are very important as regional policy makers need to create a collaborative environment that is open to innovation and sharing of knowledge and resources. Regional attitude towards risk is also very important.

.From the firms surveyed, 76% (32) 'agree' or 'strongly agree' that the region is a tolerant and attractive place for people with diverse backgrounds. The Council of Competitiveness (2006) stated that regions that value racial and cultural diversity may be better suited for innovation as innovators by their very nature often function outside the norm. Regions that respect and embrace diversity may have an easier time cultivating innovators.

From the firms surveyed, 53% (18) 'agree' or 'strongly agree' that new residents can integrate into the regional business community and 44% (15) agree or strongly agree that the region celebrates the growth of companies not just the absolute size of companies.

5.3.2 Factors perceived as inhibitive for RIS development

This section will look at what factors have inhibited the innovation activity and in turn the growth of a regional innovation system in the BMW region.

Strategic decision makers in biomedical firms in the BMW region have rated the factors they believe as inhibitive for RIS development. Figure 5.11 below will illustrate the top findings and then analysis will follow.

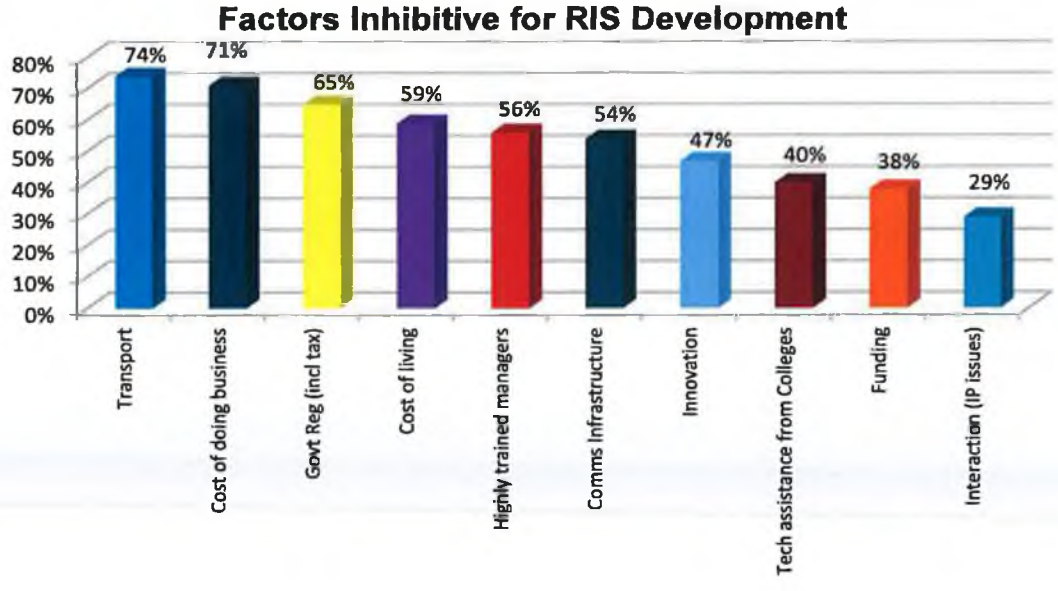

Figure 5.11: *Factors inhibitive for RIS Development*

5.3.2.1 Infrastructure

74% (25) of respondents rated transportation as a major factor affecting their business. Commenting on transportation the **Product Innovator** interviewed stated *'the biggest challenge is access, in and out of the region. It is important that this is good when industries come to view the region. This then helps to create a good impression with strategic managers in other countries as this is the first impression they get off the region when they leave the airport'.* According to a representative from the **WDC** *'there has been a lack of investment in infrastructure in this region which gives the impression of isolation to multinationals coming in to view the region'.* According to a representative from **NUIG** *'Transportation in the BMW region is reasonable. Shannon airport is of critical importance. This is the major international airport for the Galway area. The road network is also very important and now there is an excellent motorway to Dublin'*

According to a representative from the **IDA**, the quality of the transportation system is critical when firms are looking at locating in a region. Fifty four percent of respondents also rated the communication infrastructure as 'being poor' to 'fair'. According to an IDA representative '*There is a need for more Metropolitan Area Networks (MANS) at all IDA sites.* It is important that the BMW region is not perceived as an isolated region. As stated previously, a difficulty the region faces is the retention of young people as they seek out opportunities in regions that offer better or alternative education or employment prospects. A representative from the **WDC** stated that *'a lot of our young people have left to go to live and work in the east of the country and also abroad. The problem with this is that innovation and creativity leaves with these types of people as there is no career path for people who stay'.* A representative from the **IDA** did also state that they find it sometimes difficult to attract multinational companies to the BMW region as they will be comparing the BMW region to the East and South of Ireland. *'If there are more graduates situated in these areas, or they have a better transportation system then the BMW region may lose out'.*

Another important issue highlighted by the **NUIG** representative is the courier service which is a major problem. *'This is inefficient. They don't share the sense of urgency,*

there is no overnight courier service and deliverable times are variable. It can take four days to get a package delivered. This is not good for MNCs in particular'. If a courier service is slow it heightens the sense of peripherality or isolation in the region.

5.3.2.2 Cost of doing business & living in the region

Both rising business costs and the cost of living are taken into account here. From the firms surveyed, 71% (24) consider that the cost of doing business in the region is 'poor' or 'fair' with 59% (20) stating that the cost of living is also 'poor' or 'fair'. According to a representative from **NUIG** *'the cost of living in Ireland and this region is high. This needs to be relooked at'.* The **Process Innovator** commented on the cost of bringing over interns to work from the US. *'When the analysis was done, Ireland was excluded as it ended up being too expensive to bring the intern over here to train'.* A **Product Innovator** also stated that they were currently trying to bring over a manager from the US to work in the Galway office (2010) however *'due to the high costs of living for the individual to relocate here from California he wasn't inclined to move'.* This again is a major factor for industries and individuals locating here. From the interviews carried out with the two biomedical firms, Ireland is perceived as an expensive manufacturing base. From speaking with the **Process Innovator** he stated that the *'managers back at headquarters are constantly looking at the cost of manufacturing in Ireland'.*

5.3.2.3 Legal & Regulatory Environment

The researcher identified that the policy makers were more critical of each other than the industries were off them. From the firms surveyed, 65% (22) state that government regulations are 'poor' or 'fair' with 56% (19) stating that government growth incentives are 'poor' or 'fair'. The two industries interviewed were multinational companies so perhaps they wouldn't have as much reliance on the agencies in the region as indigenous based industries or early stage start-ups. A representative from one of the **colleges** identifies a lack of joined up thinking between the various agencies, stating: *'there is an Enterprise Ireland resident in Dublin, this is not coordinated. We are sending documentation to Dublin to get approved which I believe should be regionalised'.*

5.3.2.4 Lack of highly trained managers

From the firms surveyed, 56% (19) stated that the availability of top or highly qualified managers in the region was 'poor' or 'fair'. According to the **Product Innovator** *'most managers are either homegrown (come as graduates and brought up through the system and trained) or else brought in from the US'.* A representative from **Enterprise Ireland** mentioned the lack of courses available to managers within the region. He mentioned the idea of creating an Irish Management Institute (IMI) in the western region similar to the one based in Dublin. The IMI provides courses to help develop and grow individuals to managerial level in Ireland. This will also help to fast-track graduates in becoming managers in multinational companies.

5.3.2.5 Lack of technical assistance for third level colleges

Even though Universities and Colleges are perceived as being 'very good' at supplying college graduates, respondents believe they are not servicing industry needs. There are some issues in relation to this as 40% of firms surveyed considered that the technical R&D from colleges is 'poor' or 'fair'. Of these respondents, 23% are Irish companies involved in product innovation. From a follow up interview with the **Product Innovator** he believed that the interaction between companies and the third level sector in the region is not working. He believes colleges are driving early basic academic research. Companies (in particular multinational companies) are looking for completed products. *'...Universities are driving their own agenda...Gmedtec in the GMIT should have been a huge success but it just hasn't taken off. I'm not sure of the reason why that is? There seems to be a disconnect between what Third Level want out of it, what Agencies want out of it and what Industries want out of it. Multinational companies want to launch new products, if that is not happening then the multinational will stop investing as doesn't meet it's strategic plan. There probably could be a better strategy, the agendas from both sides are just very different'.* A representative from **Gmedtech** at the GMIT believes *'That some companies don't want to work with the Third Level sectors as industry needs are faster and they therefore have much shorter-term goals. This is particularly true in the medical device sector due to shorter life cycle from research to product. However the pharma sector is much longer and universities need to understand*

this'. A representative from **a Third Level Institute** and a representative from **Enterprise Ireland** believe that it can be very difficult for industry to access third level colleges. When carrying out the qualitative research a representative from NUIG stated they were keen to address this. '*We are having a series of events enabling industry to come into the research centre and see what is going on'*. An example of this was an event on the 24th March 2010 entitled 'Enterprise and Technology'. Scientists, technologies and engineers demonstrated and showcased what they are doing and there was also a series of key note speakers such as Helen Ryan from Creganna and a series of talks from the College and tours of the facilities. State bodies were also in attendance. A representative from **NUIG** stated '*This event will showcase what we can do for companies. We will be sending out invitations to all the multinational companies and indigenous based companies right across Ireland inviting them to come here so we can basically show them how we can partner, provide research services, provide testing services, join them in funding initiatives etc. We need to basically, for want of a better word, sell ourselves. We have to do that because we want to embed ourselves in the technology community so we must do that.*

A representative from the **WDC** questions the professional ability of the technology transfer office in the region. Technology Transfer is the process of transferring scientific findings from research laboratories to the commercial sector. There is one such office in NUIG. He believes that the office *'should be in significant demand, however it is still undercooked'*. He also believes there are only a few players in the region who are skilled in patent development and exploitation. This is perhaps something that needs to be addressed.

5.3.2.6 Lack of funding

38% (13) of respondents stated that finance from VC's, Banks and Private investment was 'not good' or 'fair'. Availability of financial funding doesn't rate high among biomedical companies in the BMW region. From the firms surveyed, 6% considered VC Funds (6%) and Private Capital Funds (9%) to be 'good' or 'very good', 57% considered VC Funds and 53% (18) considered Private Capital Funds in the region as 'not

applicable' to them perhaps due to dealing with financial institutions in their home country.

Bank Funding is rated slightly higher for biomedical companies. From the Irish firms surveyed (all in Product Innovator category), 15% believe VC Funds to be 'good' or 'very good' and 23% of Irish companies surveyed consider Private Capital Funds and Bank Funds to be 'good' or 'very good'. According to a representative from a **VC** company in the region *'its quite difficult for start-ups in the BMW region to get VC funding as Enterprise Equity only invest in approx three per year at maximum. The delta would be one to two per year. This is very much based on picking a few and then hoping that those one to two will prosper which will pay for the others that don't.* A quarter of the companies Enterprise Equity invest in are from the Medical Device sector and include firms such as Vysera, Zerusa, Orakine (Pharma), Galway, Avenue Moulding (Sligo), Ansamed (Roscommon) and TopChem Laboratories (Sligo). Lack of financial capital is one of the most common problems for young biotechnology firms and start-ups. From a qualitative interview with a representative from **NUIG**, he believes the investment community is quite slow and probably more risk averse than in other countries *'one of the places where projects fail or disappear is when they are trying to get off the starting block and often that first big step is often the hardest and where the investment is most needed and risk is highest and uncertainty is greatest e.g. a scientist comes up with some interesting pieces of technology, he has the patent and wants to spin it out. In some way getting that first million is always by far the hardest, maybe not a million but definitely the first few hundred thousand'*. In Ireland many investors come in after they have received backing from an agency first. He identifies two areas of concern:

- Initial stage - looking for €500k to get things moving for one year (first investment)
- Later stage - When a company is looking for clinical trials which needs heavy investment. This is the second stage. At this stage you would be talking about tens of millions. '*Lots of companies have found it very difficult to jump through that gap'*.

In relation to Private Capital there is a Halo Business Angel Partnership run by Westbic operating in the region. According to a representative from the **Halo Business Angel Partnership** *'the problem for Business Angels is the lack of history of private equity investment in Ireland. We are developing initiatives in late 2009 and are looking at building this through coffee mornings and closed seminars by inviting five to ten like minded people. We are looking at getting a cohort of private investors. This runs very professionally in Dublin. Companies looking for investment need to be very professional and very tuned in about market opportunities'*. There is currently a quite informal approach trying to find investors. In the past they were more focused on professional accountancy practices, local consultants etc. They found however that they were not effective as it was more about fee income. Another issue is that the Manager of the Halo Business Angel Partnership works three days per week, the majority of his time is spent developing project proposals. He stated *'I don't have enough time to make a concerted drive for investors. I mainly meet them through networking'*. This is therefore quite difficult as finding private investors takes a lot of time and planning.

5.3.2.7 Lack of Interaction between actors

Another issue that emerged is the lack of interaction with various industries in the region. From the firms surveyed, 29% (10) 'disagree' or 'strongly disagree' that people from different industry and economic sectors frequently interact in the region. A reason for this may be the issue of trust. From the qualitative interviews trust emerged as a major issue when it comes to networking in the biomedical sector. Even when interaction occurs between related industries it is quite often kept to a minimum due to Intellectual Property (IP) issues. IP protection incentivises firms to innovative. Without this protection, companies would be unwilling to invest their time (long lead times) and money (very capital intensive industry) into the R&D that is needed for this industry. According to one **Product Innovator** *'a good IP portfolio management is crucial for the success of a biotech company'*. According to a representative from a VC company *'for a start-up company looking for investment, IP helps to reduce the risk as investment will only be provided if the company has patented their new innovations'*. Companies compete to create the most valuable IP. There is a difference of opinion on this between

Colleges and Industry as a representative from **NUIG** stated *'we do not believe that this is an issue, every company we deal with there is a partnership agreement signed by the company and the university and this covers IP'.* Background IP (company owns before the work commences) remains protected and Foreground IP (subsequently created due to work) is essentially shared and an agreement is put into place to allow the company to licence any new technology. The company also has an option of exclusivity or not depending on what the company wants. *'If we agree to do a project in cardiac repair for instance, the partner might say I don't want you to do a project on cardiac repair with anyone else, I want exclusivity, we have done this. Others however are happy with non exclusive'.* NUIG have also dealt with large multinationals and have been able to formulate an IP agreement with them, so therefore they do not perceive any issues. *'It does need careful management as information is passing back and forth all the time and some of that info is very valuable. We have to be careful how we document and talk about things'.* The **Product Innovator** and **Process Innovator** interviewed also believe that IP is a major issue therefore there seems to be a difference of opinion between third level colleges and biomedical companies. One public agency believes that biomedical firms are wary of IP issues and are not willing to talk to universities or Institutes of Technologies as the Collages themselves may believe.

5.3.2.8 Culture

From the firms surveyed, 47% (16) considered that the level of innovation in the region is 'poor' or 'fair'. This is a factor that must be looked at as innovation is at the core of building and developing a RIS. From the firms surveyed, 41% (14) 'disagree' or 'strongly disagree' that local government institutions eagerly partner with the private sector to promote new business development. In order for innovation to be encouraged these types of issues must be tackled in the region.

5.4 Summary & Conclusion

This chapter analysed the findings obtained through quantitative research and follow on in-depth interviews with the selected individuals within the BMW region. It commenced

by summarising the profile of biomedical companies surveyed such as such as levels of innovation, ownership of firms, employee numbers and R&D activities. It also looked at the biomedical firms relationships with the various actors in the regions and also explored the markets and strategies pursued by these biomedical companies.

The main findings explored the factors conducive to the development and growth of an RIS in the BMW region. These factors include quality of life and attractive place to live, third level institutes, availability of skilled workers, cluster organisations and availability of suppliers and related firms in the region.

Factors inhibitive to the development and growth of an RIS in the BMW region included infrastructure (transportation and communication), cost of doing business and living in the region, government regulations, lack of highly trained managers and also the level of innovation in the region perceived as being quite low.

The next chapter will discuss the significance of these findings.

CHAPTER SIX: DISCUSSION

6.1 Introduction

This chapter draws conclusions from the findings presented in Chapter 5 and will contribute to the academic debate around the factors influencing innovation activity and therefore the development of an RIS in a peripheral region of an economy. Many findings were highlighted such as quality of life and the BMW being an attractive place to live all of which concur with previous literature on this topic. Cluster organisations were also deemed valuable to the region which is something that regional policy makers should develop and grow. However the researcher has decided to focus on the three main findings emerging from this research which may be categorised as follows:

1. Third Level Institutes
2. Infrastructure
3. Financial Capital

To reiterate again, the primary objective of the research is as follows:

- To explore the factors influencing innovation activity and therefore the development of an RIS in a peripheral region of an economy'. Three main factors have been chosen and will be investigated further in this chapter.

The primary objective may be specified in terms of the following secondary objectives:

- To develop a profile of a cluster of a RIS operating in a geographically peripheral region including economic contribution to the region and innovation activities. The biomedical industry has been identified in Chapter 4.

- To identify, specify and analyse the innovation activities of biomedical firms in the BMW region of Ireland. This has been conducted in Chapter 4.
- To investigate and evaluate managers' perceptions in selected biomedical industries on factors which inhibit the development of a RIS in the biomedical sector in the BMW region of Ireland. This has been conducted in Chapter 5 and these findings will be discussed in more detail in this chapter.
- To develop recommendations for continued development of a RIS in the biomedical sector in the BMW region of Ireland which will be explored and discussed in this chapter.

6.2 Third Level Institutes

Third level institutes (TLIs) were identified as a very important factor in the development of a RIS. The BMW region has a high level of educated individuals and skilled labour available in the region which contradicts the literature. Human capital levels in peripheral areas on average are lower than in urbanised regions (Mueller et al. 2008;Van Stel and Suddle 2008). As mentioned previously in chapter two this is often due to employment and entrepreneurship opportunities being greater in core regions. More specific factors or issues identified in this peripheral region were the ability of the Knowledge Institutes to respond to industry needs and their accessibility to industry, each of which is dealt with below.

6.2.1 Responding to Industry Needs

From the research conducted, 79% of respondents considered educational institutes to be 'good' or 'very good' in the BMW region, with 74% considering the supply of skilled labour to be 'good' or 'very good'. However, the research also identified that an expectation and innovation deficit exists between industry and TLIs in the region.

6.2.1.1 Expectation Deficit

In relation to the expectation deficit, respondents perceive TLIs to be teaching rather than research oriented, hence the perception of respondents is that little research is produced and even less that is of interest for innovation or commercialisation. One respondent from a state agency commented as follows: *'there is a willingness from colleges but the expertise is just not there. An audit needs to be conducted in order to understand the deficits that need to be addressed. The number of spin out's from Institutes and Universities is very small. The Institutes of Technologies should be pouring out companies as they are meant to be nearer industry'.*

One respondent, a Product Innovator, suggested that the interaction between companies and the third level sector in the region is not working. He believes colleges are driving early basic academic research, whereas companies are looking for completed products. As these findings indicate academic researchers are driven primarily by research, communicating their results and building reputation among peers. Authorship is often a primary basis on which many academics are evaluated for employment and promotion. Conversely companies have much shorter term goals: commercial products, leading to profit and employment. As stated in the findings, both industry and academia are driving different agenda's.

6.2.1.2 Innovation Deficit

An innovation deficit is something very visible between industry and TLIs. A Third Level Institute representative stated that there are lots of skilled workers available in the region but suggested that more applicable programmes should be developed. He stated *'it would be good to have more Masters Degree Programmes such as biodesign at Stanford. This programme looks at creating the next generation of medical technology innovators. Courses such as this would help to draw more graduates into the region'.* NUI Galway recently took the first step in bridging this gap by launching BioInnovate Ireland (a specialist training programme in medical device innovation, modelled on Stanford University's Biodesign Programme).

Fifty six percent of respondents stated that the availability of top or highly qualified managers in the region was poor or fair. A state agency representative mentioned the idea of creating a Management Institute similar to the Irish Management Institute (IMI) based in Dublin, which would provide courses to help develop and grow managerial skills base within Ireland. Respondents proposed that Third level institutes should also look at developing and offering management programmes to specific sectors (e.g Biomedical, ICT, Engineering, Energy, Services etc).

The research therefore concurs broadly with Asheim et al. (2003) suggesting that the supply of skilled labour is probably the most important innovation support that TLIs can provide to SME's. A RIS must attract high skilled graduates and labour, and TLIs can facilitate this by offering specialised courses, training, R&D capabilities, test labs, etc (Kautonen, 2006). In relation to the expectation deficit, there are often considerable differences in the capability of universities to effectively transfer their knowledge, and of firms to effectively absorb such knowledge (Huggins, 2008). Bowie (1994:12), in attempting to explain this conflict of interest, suggests universities become *'caught between two of its compelling interests'* because of its relationship with corporate sponsors.

Wolfe and Gertler (2003) similarly highlighted the attraction and retention of talent as an important success factor in RIS development. In relation to the innovation deficit, incentives to attract highly skilled managers to locate in the BMW region needs to be explored by policy makers and funding agencies. Stanford, for example, didn't turn Silicon Valley into a high-tech cluster on its own, regional actors built the local infrastructure that was required. Similarly many of the high tech clusters such as Boston and Austin in Texas emerged in this manner.

6.2.2 Accessibility of TLIs to industry

Third level institutes also need to be accessible to the actors in the innovation system. From the interviews conducted, respondents indicated that it can be very difficult for industry to access TLIs in the region. As a first step in helping to bridge that gap, a joint

collaborative initiative called MeTRIC between Colleges in the region (NUIG, GMIT, AIT, Sligo IT and UL) was announced in 2011. MeTRIC will *'enable the business community in Ireland and internationally to engage in seamless multi-institutional research and development, industry support services, as well as education and training. MeTRIC's services will be crafted and tailored to meet the specific challenges of industry, to design, develop, manufacture, and market new Medical Technologies, products and services, and to enhance existing products and services'* (IBEC website Aug 2011).

Andersson and Karlsson (2002) similarly suggest that policy strategies could be oriented towards the promotion of accessibility in the development of a RIS. This is a welcome step towards bridging the gap between industry and academia as accessibility into TLIs has historically been a significant issue for industry in the region.

6.3 Infrastructure

This thesis highlights the need for regional and national policy makers to focus and develop the transportation and communication infrastructure in the BMW region. Investment in infrastructure in the region, particularly road and communication, must be prioritised. This finding also concurs with information in the literature review. In chapter two the researcher stated that the development of infrastructure is very important not only in attracting new industry into a region but retaining companies and individuals in the area Infrastructural deficits leave regions at a disadvantage. Evidence from the US suggests that the heavy infrastructure investment in the United States during the 1950s and 1960s was a key, and previously underrated, factor in the strong economic performance of that period (Aschauer 1989, 1990). In many situations, the provision of regional infrastructure can act as a catalyst for the generation of local agglomeration economies, because infrastructure can be regarded as a local non-traded input (Marshall 1920). Concurrent with this research, it was reported that several biomedical companies threatened to relocate operations if €220m was not committed by the government to improve the road infrastructure in the region, in particular the N5: a 134km national route running through Longford, Roscommon and Mayo. Mr. Pat O'Donnell (MD of

Allergan Pharmaceutical in Mayo) stated *'the lack of proper infrastructure means that we are being put at a competitive disadvantage. If we're trying to attract industries to the West, create and keep jobs here, then having what is a Third World road is going to make life difficult'* (Mayo News, May 2010). Investing in infrastructure is a must to encourage more biomedical industries into the region, thereby increasing employment which consequently helps the growth and development of a viable biomedical cluster. For bio-tech laboratories, internet based companies and data storage centres, non interruptible power is critical, as is access to backup power and telecommunication lines. A first step in helping to bridge this gap was announced by Irish Government Officials in 2011. The planned high speed fibre optic cable linking New York to Europe via the West of Ireland will mean that Ireland (and in particular the west of Ireland) could become a preferred global location for multinational companies and also a preferred location for indigenous enterprises to develop, grow and compete globally.

Seventy four percent of respondents rated transportation as a major factor affecting their business. The importance of a well developed infrastructure in particular to peripheral regions cannot be underestimated and this fact is recognised by Goodbody (2000) who stated *'peripheral regions will stand to benefit to a greater extent than core regions from transport improvements'*. The BMW Regional Assembly have also highlighted this point with the Irish Government in 2011, stating: '*To be competitive in regional locations, enterprises must have access to infrastructural facilities that are at least on par with their competitors.* However improvements in infrastructure alone will not necessarily lead to the growth of a RIS. It must be combined with other factors such as quality of educational facilities, availability of skilled labour and availability of financial capital etc.

6.4 Financial Capital

Financial capital was identified in the Findings as an impediment to the development of a RIS. Lack of capital in a region can hinder industries, particularly start ups, as they must go outside of the region to obtain funds. This disincentivises firms from setting up in the region or being attracted into the region. If the supply of financial capital is an

inhibiting factor for the establishment of new firms in the region then policy makers need to look at providing incentives to VCs to invest in their regions. This absence of financial capital in the BMW conflicts with developments internationally as a biomedical cluster has developed despite the absence of VC funding locally. This anomaly may be explained by the preponderance of multinationals within the bio-medical cluster. Multinationals would often obtain funding from their home offices therefore the dominance of US biomedical companies in the region may not be looking for VC funding as they are able to obtain elsewhere.

Martin (1989) and Mason and Harrison (1991) also found that there is a high degree of spatial concentration of venture capital activity, both in terms of firms and investments, in core regions at the expense of peripheral, economically lagging, regions. Cortright and Mayer (2002) report that since 1996, 75% of new venture capital in the US was located in the five largest biotech clusters (Boston, San Francisco, San Diego, Seattle and Raleigh – Durham). In a high technology cluster such as Silicon Valley or Cambridge, venture capital is abundant and private services thrive even though risks are high (Keeble et al 1999). More than half of the 1,000 venture capital offices listed in *Pratt's Guide to Private Equity and Venture Capital Sources* are located in just three metropolitan areas – San Francisco, Boston, and New York. More than 49% of the U.S.-based companies financed by venture capital firms are located in these same three cities (Chen et al, 2009). Similarly, Niosi (2000) notes that in Canada biotechnology firms tend to cluster in regions where VC is abundant.

The lack of VC funds in Ireland and in particular the BMW region may be an issue in the future in particular when competing against other biotech regions. One initiative in addressing this gap was announced in March 2012 with the Minister for Jobs, Enterprise and Innovation Richard Bruton issued a global call to leading Venture Capitalists to signal their interest in establishing a presence in Ireland. As part of that announcement, the Government through Enterprise Ireland will invest a total of more than €60 million in venture capital funds which establish a presence in Ireland. Policy makers must

ensure that established biomedical companies and start-ups are able to access these new VC funds if needed.

6.5 Recommendations

Regional Innovation Systems should take all aspects of what Eriksson (2000) calls, a 'complete' RIS into account i.e. access to financial capital (VC, grant agencies, banks etc), quality of infrastructure, quality of educational facilities, networks and business associations, as these are all very important elements of a RIS. This section will outline recommendations on how these issues can be addressed in order to further develop the biomedical RIS within the BMW region.

6.5.1 Education

Education has been identified as an important factor in the growth and development of a region by industry and supporting agencies. This was reiterated frequently throughout the research process. The research highlights that knowledge providers and skilled labour are the most important factors to consider in developing a RIS. This therefore must become a primary concern for regional and national policy makers in the BMW region. Third level institutes and policy makers, working together, must understand the education and research competencies that industry in the region demand if the BMW region wishes to remain a competitive location in a global knowledge-based economy.

However the educational sector within the region has other issues that it must explore. To address some of the issues coming from the findings, recommendations are cited below.

Firstly, it is recommended that third level institutes become more accessible to the general public. The Metric initiative discussed earlier is one step towards achieving this. Accessibility could also be improved by TLIs hosting educational seminars on recent development in the life sciences area and attract well known speakers to talk on issues and opportunities within the biomedical area.

A second recommendation is to develop a specific biomedical network, perhaps modelled upon the MedTech network in Stanford. Pineiro (2007), commenting upon MedTech, states: 'The network is composed not only of Stanford faculty but also, and this is likely one of the reasons behind its success, of clinicians from Stanford's health care system, of venture capitalists and other investors from the area (Silicon Valley). It is also composed of representatives from the surrounding medical device industry, of famous inventors (Simpson, Fogarty, etc.) and even lawyers specialised in medical technology and entrepreneurship'. Bionow is another example of a cluster support group for one of the UK's top three bio clusters. Located in the northwest of England's, Bionow covers areas such as the biotechnology, pharmaceutical and healthcare technology industries. It is linked in with the NHS and the UK Colleges in the North West of England. The biotechnology companies in the BMW region must consider developing such a network. This could be a central point for information, technology transfer, export and inward investment support and for promotional purposes.

In setting up a new network, all support agencies must encourage the formation of cluster networking organisations and raise broad regional awareness of, financial support for, and participation in local and regional cluster building efforts. Policy makers have a role to play in supporting the inter-linkages between organisations. In Arizona, for example, different clusters bid for public funding and all are charged with making interventions which benefit the cluster as a whole. This ensures cluster members are pro-active, work together and establish mutual goals and objectives. This in turn ensures industry buy-in.

Support agencies must inform regional business about the benefits of collaboration and support those industries and TLIs who collaborate. In Germany the government launched the 'Bioregio' initiative back in 1996. This initiative required companies to submit ideas for the development of biotechnology on a regional basis. The main selection criteria for financial support were based on levels of collaboration between all parties (e.g. industry, universities and public sector agencies). This highlights the importance of collaboration among biomedical firms in developing a future regional innovation strategy. However, success requires an understanding of the real reasons for lack of innovation in a region so these can be systematically addressed.

Support agencies such as Enterprise Ireland, the Industrial Development Authority, Irish Medical Device Association and the American Chamber of Commerce work well individually with their own members. This however provides limited interaction and collaboration between indigenous industries and multinational companies. There needs to be more collaboration between the IDA, Enterprise Ireland, the IMDA, American Chamber of Commerce and the industries they all support. New biomedical start-up companies would benefit enormously from exposure to the experiences of larger more established biomedical companies, from a more co-ordinated approach.

A third recommendation is to develop more work placement programmes between TLIs and biomedical companies. This would enable under graduates and researchers to work with biomedical companies and bridge the gap between academia and business by gaining real life experience... This would also provide decision makers in TLIs an understanding of what teaching is required by industry in order to develop higher level graduates.
More applicable cutting edge courses for the biomedical sector also need to be developed. Biomedical industry representatives could for instance be invited to TLI committee meetings regarding the development and implementation of biomedical courses, programme design, etc. Developments such as this would create a strong relationship between industry and TLIs.

A fourth recommendation is to develop higher level skills within industry. Specific management courses which develop higher level managers here in Ireland and in the region is an imperative. Policy makers can assist in the development of next generation of managers by:

1. Developing a specific Management Institute in the region similar to the IMI in Dublin, or developing a branch of the IMI in Galway specific for the BMW region.
2. Creating a training programme for managers in specific sectors.

3. Creating internships and mentoring opportunities for outstanding graduates and younger professions. Companies need to develop processes for identifying and recruiting the next generation of business managers in the region.
4. Offering specific courses to industry such as: intellectual property for biomedical start-ups, VC funding for established and start-up biomedical companies are ideas which should be developed.
5. Developing incentives which would enable industry to hire graduates / researchers and innovation managers within the region is another suggested initiative.

A fifth recommendation is developing incentives that encourage investment in R&D, industry-sponsored programs and internships. Providing financial capital to continue to fund basic research through the educational budget must be prioritised. Some recent initiatives are noteworthy, for example in December 2011, the Minister for Research and Innovation, Sean Sherlock, announced additional improvements to R&D tax credit to grow SME's and multinational companies. Public and private funded R&D has been highlighted as a key factor in the development of Stockholm (Blau, 2001); Cambridge (Keeble, Lawson, Moore and Wilkinson, 1999); Baden-Württemberg (Krauss and Wolf, 2002); Munich (Sternberg and Tamasy, 1999) and Sophia-Antipolis (Longhi, 1999). Therefore, it is considered that this is something the Irish government must develop.

A final recommendation on the educational sector is to develop a competency centre in the region. In 2003 the Royal College of Surgeons in Ireland developed a centre for innovation in surgical technology and more initiatives such as this will have to be developed and those already developed will have to make sure they are adding value to industry. One respondent (a product innovator) suggested that in order to mitigate against high costs in the region, competency facilities should be developed. He stated *'A large part of medical device design is to understand how the product is used in in-vivo conditions. We use both acute and chronic animal models to test our devices. There is no*

such facility in Ireland. We either go to the US or Europe to carry out this work. It would be a big benefit to have this type of facility and capability in Ireland'.

6.5.2 Infrastructure

Another critical finding which emerges from the research is infrastructure in the BMW region. The findings have shown that infrastructure is perceived as a very important contributor to the growth of a RIS in the BMW region of Ireland. Upgrading regional infrastructural facilities (both physical and technological) in order to compete on a global scale is urgently required. Improving educational facilities (including research centres and incubation centres) by upgrading physical infrastructure and installing other amenities to create a better learning environment should also be prioritised

6.5.3 Financial Capital

The findings suggest there is a need to look at sector specific VC capital funds and promote international partnerships with multinational companies. Without a well-developed regional concentration of VC firms, the BMW region will be disadvantaged in terms of access to VC capital resulting in companies within the region having to spend a large amount of time elsewhere looking for these funds. It is interesting to find that most academic spin-offs in Europe are still in the infancy stage, in particular when compared to the US (Ndonzuau et al., 2002), thus threatening their prospects of progressing to fully fledged enterprises. A respondent from one of the Colleges in the region suggests *'perhaps universities needs to look at setting up their own venture capital funds in order to help them to fund their own technologies'.* Lack of financial capital is one of the most common problems for young biotechnology firms and start-ups as a lot of VC companies are now looking at later stage deals rather than early stage technology based ventures. The lengthy process of turning biotechnology start-ups into commercial companies demands considerable financial injections after the first stage of company development.

Porter & Stern (2001) argue that building innovative capacity in industries has a strong relationship to a country's overall competitiveness and level of prosperity, as

'innovation has become perhaps the most important source of competitive advantage in advanced economies' (2001:15). RIS and clusters can play an important role in achieving and developing the competitive advantage for a region.

6.6 Summary & Conclusion

This chapter has interpreted and discussed the main research findings. The aim of this study is to be able to contribute to the academic debate around the issue of regional innovation systems (RIS') in peripheral regions in particular with particular focus on the BMW region of Ireland in this thesis. Many findings were highlighted such as quality of life, the BMW being an attractive place to live etc. In the Literature Review factors which challenge regional prosperity include globalisation, industrial make up of a region, dependency on indigenous industry and outmigration. All of these factors have been highlighted throughout this thesis. Exploring a competitive advantage is extremely important for a region. Quality of life is something which managers within the region recognised as being important as well as being an attractive place to live. The quality of third level graduates and skilled workers within the region was conducive to the innovation system developing further.

The researcher focused on the three main findings categorised as follows:

1. Third Level Institutes
2. Infrastructure
3. Financial Capital

Recommendations were highlighted such as:

- Accessibility into Third Level Institutions and Third Level Institutions hosting seminars for industry.
- Developing a biomedical network similar to MedTech in Stanford or Bionow in the UK.

- Developing greater collaboration between agencies and supporting institutions within the region.
- Involving the biomedical industry in developing specific, appropriate and innovative biomedical courses and developing management courses.
- Upgrading the regional infrastructure to compete on a global scale should be a priority for policy makers in the region.
- Specific VC funds need to be explored and developed in order to make the region a competitive and renowned biotech RIS.

All of these issues need to be explored by policy makers within the region if the region is to grow and develop and compete against other biotechnology clusters. This can only be done by involving all firms and supporting institutions within the region. A suggested definition for RIS in chapter two was planned and organised collaboration between firms and supporting organisations within a region, these may include third level institutions, R&D organisations, technology transfer units, business associations, training organisations, financial institutions etc. Planned and organised collaboration is essential in the development of relationships conducive to the generation and diffusion of knowledge and innovation. The next chapter will summarise the main findings, discuss the limitations of this research, discuss the implications of this research for the various organisations involved and suggest a number of areas that may require further research.

CHAPTER SEVEN: CONCLUSIONS

This chapter will conclude the thesis with a summary of the main findings and suggest opportunities for future research.

7.1 Summary of main findings

The main findings highlighted factors that are conducive and prohibitive to the innovation activity of biomedical companies in the BMW region. These factors include:

1. Third Level Institutes
2. Infrastructure
3. Financial Capital

Third Level Institutes need to focus more on research in particular applicable research for industry in the region. More applicable innovative courses specific to industry in the region need to be developed. Accessibility of TLI's to industry needs also to be addressed and developed further. A open door policy needs to be explored in order to encourage greater collaboration and research.

Investment in infrastructure in the BMW region needs to be a priority in order to address the geographic peripheral issue. Policy makers in the BMW region must work in order to ensure that the region does not become isolated.

Lack of funding needs also to be explored in order to incentivise more firms to locate in the region. If the BMW region wants to become a major biotech region, this factor needs to be addressed as other well known biotech clusters attract a high concentration of VC activity already. If this issue is not addressed the BMW region could begin to lag.

7.2 Limitations of Research

At the start of the research process and during the collection of data there was an economic boom and the Irish economy was progressing quite well, however during the research process the country of Ireland experienced a downturn. Responses therefore may have been slightly different had it been later due to economic situation of the region. Towards the end of the research study, one company had announced redundancies of 199 staff. The reasons cited were competition and economic climate.

It was also very difficult to obtain certain information. Intellectual Property (IP) information is an example of this. It was very difficult to obtain patent numbers for the biomedical firms in the BMW region. As this is an industry that is heavily reliant on IP protection one can only assume that the numbers are quite high.

Limiting the qualitative data to just two biomedical companies can mean that the researcher can receive a limited view of all biomedical companies within the region as needs differ from industry to industry.

The researcher is also working within the educational / innovation sector in the region therefore the research had prior contact contacts with some industries and agencies within the region This may in turn have influenced some of the responses (both positively and negatively).

An issue when defining RIS' is that it is very difficult to define an actual region. Definitions vary therefore regional identification can be difficult.

7.3 Implications of Research

While this research represents a good beginning, it is the researcher's hope that it will only act as a springboard for further dialog amongst organisations and key supporting institutions within the region.
Policy makers need to be involved to bring these key groups together and encourage more collaboration and joint thinking. The recommendations listed in the previous

chapter are not exhaustive and some of these might be implemented going forward. Infrastructure within the region needs to be seriously addressed and deficits improved, also VC companies need to attracted into the region and funding for third level institutes needs to be explored for spin out companies. Higher level Educational Institutions need to understand the criticisms outlined in this thesis and need to work with all key stakeholders to ensure that these issues can be resolved. As stated in the previous chapter, planned and organised collaboration is essential in the development of relationships conducive to the generation and diffusion of knowledge and innovation

7.4 Future Research

The findings from this thesis indicate that there is a biomedical regional innovation system located in the BMW region but policy makers along with industry and TLIs need to work together to grow and develop this RIS further. This research provides valuable insights into factors that are conducive and inhibitive to the innovation activity and the future development of a RIS in the BMW region. The research was focused on the BMW region of Ireland and therefore it is important not to generalise all RIS,' as RIS'are not homogenous. A "one-size-fits-all" approach to innovation systems that treats all regions in a similar way is not appropriate. The size and location of the region has not hindered the emergence and development of an innovation system in the BMW region. The RIS evident in the BMW region may be viewed as small when comparing it to some of the more developed regions such as Baden Würrtemburg in Germany, Tampere in Finland and Silicon Valley in the US however it can still nonetheless be classified as a 'system'. As Maurkesen (1999) stated *'we cannot yet determine what a RIS would look like in reality'*.

More research however must be carried out on the causal relationship of a RIS. It is difficult to know if RIS' drive policy makers or if policy makers drive the development of a RIS. Regions are not innovative themselves per se, but the innovation process is an interactive process and commercialised innovations are most often a result of co-operation between many different actors (Doloreux, 2003). Perhaps it is the case where RIS' develop and grow without any help or guidance from policy makers?

Finally future research should also include factors such as the peripherality and the likelihood and type of innovation occurring in firms located in these regions. Asheim & Isaken (1996) state that peripheral regions are mainly composed of smaller industries undertaking incremental innovations and the important novelties often hail from urban regions. Even though the BMW region does have a high dependency on traditional industries it also managed to attract and develop high technology industries creating significant intellectual property. Many studies undertaken on RIS' have been focused on metropolitan areas. This study therefore has reported on key factors and dynamics leading to innovation and the transformation and growth in a peripheral context. Every region whether peripheral or urban has its own specific characteristics in terms of competencies, traditions, institutes and systems of relations between institutional and social actors. Therefore every region must look at its own specific characteristics and try to build on these. Insofar as this research has answered some of the questions posed, many more remain unanswered. Comparison between the BMW region and other similar peripheral regions facing similar challenges would be worth exploring as this may provide significant insight for policy makers in the BMW region.

7.5 Summary & Conclusion

This chapter concludes by raising some new questions that have evolved from the research findings and, therefore, proposes some issues and scope for future research to be undertaken. In this thesis the possibility of a RIS developing in a peripheral region has been presented and productive points for future research on this theme have been suggested.

It appears that certain factors influence the development and growth of a RIS most notably the quality of the educational system which ensures a skilled labour force for industry located in the region. The TLIs in the BMW region need to focus on the educational requirements of the biomedical industry in order to anticipate and meet the needs of industry. Other factors such as infrastructure and financial capital are also important parts of the RIS that need to be developed further in the BMW region.

This research provides valuable insights into the factors that impact on levels of innovation and the development of a Regional Innovation System.

This research hopes to have provided a contribution to a better understanding of regional innovation systems in peripheral regions with a view of improving their effectiveness by understanding factors that help these RIS' develop and grow further.

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APPENDIX A

SELECTED EXAMPLES OF REGIONAL INNOVATION SYSTEMS

Table 6.1: *Selected examples of Regional Innovation Systems*

Name of Study (Author)	Regions studied
Regional innovation systems designing for the future (REGIS) (Cooke et al 2000)	11 regions in the EU and in Eastern and Central Europe
Nordic SMEs and Regional Innovation Systems (Asheim et al 2003)	13 Nordic regions
Regional innovative clusters (OECD 2001)	10 European regional clusters
European Regional Innovation Survey (ERIS) (Sternberg, 2000)	11 European regions
SME Policy and the Regional dimension of innovation (SMEPOL) (Asheim et al 2003, Todling and Kaufmann, 2001)	9 European Regions

APPENDIX B

RESEARCH INSTRUMENT

The Empirical Analysis on factors that impact on levels of innovation and the development of a Regional Innovation System

Background to company

1. **What year was your business founded?** _____

2. **How many people are currently employed in the business?** _____

3. **What best describes the primary industry focus of your company?** _____

4. **Does your company sell (export) products or services outside of Ireland** Yes ☐ No ☐ Don't know ☐

5. **Where is your business headquartered?** In the region ☐ Elsewhere in Ireland ☐ Outside Ireland ☐

6. **Where are the main competitors of the company located?** In the region ☐ Elsewhere in Ireland ☐ Outside Ireland ☐

7. **Where are the main customers of the company located?** In the region ☐ Elsewhere in Ireland ☐ Outside Ireland ☐

8. **Where does your company purchase from?** In the region ☐ Elsewhere in Ireland ☐ Outside Ireland ☐

9. **What kind of changes have taken place in the markets of your main products of services over the last three years?**

Domestic markets have	decreased ☐	been sTable ☐	grown ☐
If exporting, export markets have	decreased ☐	been sTable ☐	grown ☐

10. **What kind of changes have taken place in competition in the last three years?**

In domestic markets, competition has:	decreased ☐	been sTable ☐	grown ☐
In export markets, competition has:	decreased ☐	been sTable ☐	grown ☐

11. **Did the company have its own R&D activities in the years 2004-2008?**

No ☐ Yes occasionally ☐ (single development projects) Yes, regularly ☐

12. **If the company had R&D activities in the year 2004-2008 how large were the R&D expenses on average?** On average _____€ / year

13. **Please estimate the average amount of R&D Personnel in the company in the years 2004-2008?** _____full-time _____part-time

14. **Please estimate to what extent there were changes in the following functions of the company in 2004-2008**

(Please circle answer that is most appropriate)	**Not at all**				**Very much**
Products and services	1	2	3	4	5
Market areas and customer segments	1	2	3	4	5
Co-operations with other companies and organisations	1	2	3	4	5
Other, please specify_____	1	2	3	4	5

15. **How would you describe changes in products and services in the last three years?**

(Please circle answer that is most appropriate)	**Not significant**				**Very significant**
Minor improvements of the existing products	1	2	3	4	5

Major improvements of the existing products	1	2	3	4	5
Introduction of a new product based on existing knowledge / technology or adding a new type of function to an existing product	1	2	3	4	5
Introduction of a new product based entirely on new knowledge / technology	1	2	3	4	5

16. How is the company going to maintain its competitive advantage in the future?

(Please circle answer that is most appropriate)	**Not Important**				**Very Important**
By developing the qualifications of its personnel	1	2	3	4	5
By developing marketing	1	2	3	4	5
By investing in new foreign export markets	1	2	3	4	5
By developing new products	1	2	3	4	5
By investing in production automation	1	2	3	4	5
By cutting down labour costs	1	2	3	4	5
By focusing on core competencies and by outsourcing	1	2	3	4	5
By intensifying the relationships with key customers	1	2	3	4	5
By developing co-operations with research institutions	1	2	3	4	5
By developing co-operation with important suppliers	1	2	3	4	5
By increasing co-operation with other firms	1	2	3	4	5
By developing internal organisation of the company	1	2	3	4	5
Other, please specify _____					

17. Has the company used external business services related to the following functions in the last 3 years?

(Please circle answer that is most appropriate)	**Not used**				**Used a lot**
Management of Human Resources	1	2	3	4	5
Personnel Training	1	2	3	4	5
Sales and marketing	1	2	3	4	5
Partner search and networking	1	2	3	4	5
Financial administration and financing	1	2	3	4	5
Information systems	1	2	3	4	5
Production	1	2	3	4	5
Research and development	1	2	3	4	5
Strategic management	1	2	3	4	5
Other, please specify _____					

In the following section we are interested in learning about how each of the following factors affect your business

(Please tick one box in each row)

	Poor	**Fair**	**Good**	**Very good**	**N/A**
1. The overall quality of the regions transportation (e.g. road, rail, port, air)	☐	☐	☐	☐	☐
2. The quality of the region's communications infrastructure	☐	☐	☐	☐	☐

	(e.g broadband)					
3.	**The cost of doing business in your region**	☐	☐	☐	☐	☐
4.	**The region's cost of living for your employees**	☐	☐	☐	☐	☐
5.	**The region's overall quality of life (cultural and recreational facilities)**	☐	☐	☐	☐	☐
6.	**The overall quality of the educational institutes**	☐	☐	☐	☐	☐
7.	**The quality of the technical assistance (incl R&D) offered to businesses from colleges / universities**	☐	☐	☐	☐	☐
8.	**The availability in the region of workers with the skills our business requires**	☐	☐	☐	☐	☐
9.	**The availability in the region of top managers with the qualifications your business requires**	☐	☐	☐	☐	☐
10.	**The availability of risk capital from Venture Capital Firms**	☐	☐	☐	☐	☐
11.	**The availability of risk capital from Financial 'Private' Investors**	☐	☐	☐	☐	☐
12.	**The availability in the region of capital from banks**	☐	☐	☐	☐	☐
13.	**The quality of the region's specialised suppliers**	☐	☐	☐	☐	☐
14.	**The proximity of customers to your business**	☐	☐	☐	☐	☐
15.	**State and local government regulations and permitting procedures affecting business**	☐	☐	☐	☐	☐
16.	**The level of taxation affecting business**	☐	☐	☐	☐	☐
17.	**The effectiveness of government growth incentives (tax breaks, seed funding, BES etc)**	☐	☐	☐	☐	☐
18.	**The quality of promotion and marketing campaigns featured in the region**	☐	☐	☐	☐	☐
19.	**The effectiveness of regional programs to help start-up businesses**	☐	☐	☐	☐	☐
20.	**The effectiveness of regional programs to train entrepreneurs**	☐	☐	☐	☐	☐
21.	**The level of innovation in the region**	☐	☐	☐	☐	☐
22.	**Presence of related firms in the region**	☐	☐	☐	☐	☐
23.	**The level of competition in related industries in the region**	☐	☐	☐	☐	☐

The Empirical Analysis on factors that impact on levels of innovation and the development of a Regional Innovation System

In the following section we are interested to understand how your relationships with other regional institutions help your business innovate. Innovation includes commercialising new products, as well as making improvements to existing products, services of business processes.

(Please tick one box in each row)

Innovation Network / Regional Institutes Level of Support	Not at *valuable*	Somewhat *valuable*	valuable	Quite *valuable*	Extremely	N/A	
1. **Universities and Colleges**	☐	☐	☐	☐	☐	☐	☐
2. **Related Industries**	☐	☐	☐	☐	☐	☐	☐
3. **Regional Suppliers**	☐	☐	☐	☐	☐	☐	☐
4. **Banks**	☐	☐	☐	☐	☐	☐	☐
5. **Venture Capital Firms**	☐	☐	☐	☐	☐	☐	☐
6. **Angel Investors**	☐	☐	☐	☐	☐	☐	☐
7. **Industry or Cluster Associations**	☐	☐	☐	☐	☐	☐	☐
8. **Entrepreneurial Networks**	☐	☐	☐	☐	☐	☐	☐
7. **Business Incubators**	☐	☐	☐	☐	☐	☐	☐

In the following section we are interested in learning about the dynamics of the business and civic environment of your region
(Please tick one box in each row)

Regional Norms and Attitudes	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. **New Residents can easily integrate into regional business community**	☐	☐	☐	☐	☐
2. **The region, tolerant and attractive place for people with diverse backgrounds**	☐	☐	☐	☐	☐
3. **The people culture in the region understands failure as a part of the learning and innovation process**	☐	☐	☐	☐	☐
4. **People from different industry and economic sectors frequently interact in the region (e.g. bankers and engineers, manufacturers and tourism providers)**	☐	☐	☐	☐	☐
5. **The region celebrates the growth of companies, not just the absolute size of companies**	☐	☐	☐	☐	☐
6. **Local government institutions eagerly partner with the private sector to promote new business development**	☐	☐	☐	☐	☐
7. **Business leaders in the region treat**	☐	☐	☐	☐	☐

	entrepreneurs, start-ups and new companies as full partners in all aspects of industry cooperation					
8.	**Business leaders proactively share information and resources where possible**	☐	☐	☐	☐	☐
9.	**Successful business people in the region invest in economic development projects and start-up ventures**	☐	☐	☐	☐	☐

If you have any comments on the questionnaire or its themes, please include them here

_____

_____

_____

Thank you very much for taking the time to complete this survey. Results of this survey will be available if requested.

APPENDIX C

LETTER DETAILING RESEARCH STUDY

The Empirical Analysis on factors that impact on levels of innovation and the development of a Regional Innovation System

Postgraduate Research
Business Studies Department
Galway-Mayo Institute of Technology
Dublin Road
Galway

Mobile: 087-9638334
Email: maria.staunton@gmit.ie

Dear Sir / Madam

I would appreciate if you could take five minutes to complete the enclosed survey. This survey will provide comprehensive data on Regional Innovation Systems (RIS) in the Border Midlands and Western (BMW)[6] region in Ireland. The purpose of the study is to explore the biomedical industry in this region and have a better understanding of the interactivity between similar firms, supports that exist with other industries, institutions and agencies (such as Universities, Banks) and infrastructural supports in order to encourage and generate innovation.

Your cooperation is sought in completing and returning this form. This survey is part of a Masters Research, undertaken by Maria Staunton with the Galway-Mayo Institute of Technology (GMIT).

This questionnaire provides us an opportunity to compare companies' abilities to renew themselves, to innovate and to maintain co-operative relationships within the BMW region. The purpose of this study is to understand a company's problems and opportunities in developing their company in the region. A copy of the research findings can be made available on request

Completing the questionnaire will should take less than five few minutes because the majority of questions can be answered by ticking the relevant boxes.
The information you provide will be treated in strict confidence and will only be used for statistical purposes only. In addition, all research material will be treated so that no single company can be recognised.

I would appreciate it if you could post back to the self addressed envelope by ***Friday 1st May.***

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6 The BMW region consists of:
Border: Cavan, Donegal, Leitrim, Louth, Monaghan & Sligo
Midlands: Laois, Longford, Offaly & Westmeath
West: Galway, Mayo, Roscommon.

The Empirical Analysis on factors that impact on levels of innovation and the development of a Regional Innovation System

Thank you very much for your kind co-operation

_____

Maria Staunton

APPENDIX D

EMAIL DETAILING RESEARCH STUDY

Dear x

I would appreciate if I could meet you for approx one hour on xxx in relation to a Masters Research I am currently completing on Regional Innovation Systems (RIS) in the Border Midlands and Western (BMW) region in Ireland. The purpose of the study is to explore the biomedical industry in this region and have a better understanding of the interactivity between similar firms, supports that exist with other industries, institutions and agencies (such as Universities, Banks) and infrastructural supports in order to encourage and generate innovation.

This interview is part of a Masters Research, undertaken by Maria Staunton with the Galway-Mayo Institute of Technology (GMIT).

Kind regards

Maria Staunton

APPENDIX E

COMMUNITY LEADERSHIP: INTERVIEW TEMPLATE

(Questions taken from the US Council of Competitiveness 2006)

• I. Interview Background and Preparation **Interview Focus** • To develop a deeper understanding about the forces/institutions that helped and hindered the region in reaching its present state of development • To assess how alliances and networks support and promote regional innovation • To explore and confirm survey results regarding regional and cluster priorities for action **Target Audience** • University/research and development community • Selected industry cluster leaders (balance of new and established companies) • Venture capitalists/financiers • Business service provider/advisors • Business associations and economic development organisations **Target Corporate Level** Officers, senior management (special interest in Director of Research and Development, or person most involved with firm's innovation policy) **Target Number** 30 interviews (more acceptable) **Distribution** Four to six interviews in each audience category/subcategory of individuals that have participated in and/or observed the evolution of the region's economy **Length of Interview** Approximately one hour Thank you for agreeing to participate today. To begin, I would like to provide a concise statement: of this project's purpose, as well as the focus of today's interview:	**Statement of General Project Purpose** • To assess the strengths and weaknesses of the regional innovation environment • To develop insights and recommendations for how the region can improve conditions that support innovative firms and people. • To catalyse action to improve the regional innovation environment **II. Interview Questions** **Regional Development** • How do you explain your region's relative economic performance compared to other regions? • Do you think the region has been successful over time, and if so why? • What, if any, are the catalytic events that led to its success? • What are the major barriers to economic prosperity that have appeared (and been overcome) at critical junctures in the evolution of this region? • Is there a regional consensus on development issues facing the region today? **Network Focus in Development** • What sort of networks or network organizations have helped the region develop? • How have the networks helped (e.g., finance, workforce development, etc.)? • How have the networks evolved over time to meet the needs of the community? • Are there any networks that have been particularly important in attracting or nurturing innovative firms? • How have they done this? How are they doing it today?

Priorities for Action (Confirmation/Deepening of Survey Results

- Why is your firm located in this region?
- What barriers do you see to expansion in this region?
- According to our leadership survey, A, B, C are priorities for your industry cluster/region to continue to successfully innovate. Do you agree? Why or Why not? Give examples?

Innovation Specific Questions

We have spoken broadly about the development of the region. Now let's turn to specific aspects of innovation.

General Innovation Issues

- What are the major sources of new ideas and information for innovation (ideas with commercial potential) been in the region?
- Where/who did they come from?
- What environmental/cultural/business factors are important to, or have an impact on, innovation in your region? Has this changed from the past? Give examples.
- Some people argue that the interaction between firms in different industries is a major source of innovation (e.g., software and entertainment = game software). Is there much of this creative interaction between different firms in your region?

Private Sector Research and Development (R&D)

- Broadly speaking, how does your company foster innovation?
- What is your company's R&D policy? What is R&D as a percent of sales?
- Do you partner in R&D with other companies in your industry? Your suppliers?
- What mechanisms (formal & informal, network-related) help move research from the lab to prototyping and to business development?
- Are there mechanisms (organizations) that support quick diffusion of technical or market information to companies in your cluster?
- If yes, describe?

University R&D (to be asked of university respondents)

- How do the universities in this region interact with businesses? Has this relationship changed (improved) over the past years? Explain.
- Are research partnerships with businesses prevalent?
- Are the partnerships focused around basic research or technology commercialization?
- Do businesses frequently and clearly state their needs from the university partnership?

Business (to be asked of business respondents only)

- How does the University support your cluster?
- Are they valuable partners in your innovation processes? How?
- Basic research partnerships?
- Commercialization partnerships?
- Providers of employees (faculty, researchers, graduates)?
- How has this changed over time?
- Has your company licensed technology from a university, private research institution, or federal lab?
- How aggressive are the universities in commercializing applied research (licensing, equity investor, incubators)?

Government (to be asked of government and business respondents)

- How effective is your state and local government in fostering the development of innovative firms?
- What policies directly impact your innovation process/results?

- Which policies have helped firms innovate?
- Which policies have hindered innovation?
- Does your state or local government work with the private sector to attract suppliers, manufacturers, and service providers related to your business? Provide examples.
- Does the state or local government sponsor or support forums to bring together government, industries, and universities? Provide examples.
- Are there any other important government or non-profit organizations that support business development?

New Business Formation (to be asked of all respondents)

- How does new business formation happen in your region? Is it predominately internal or do you attract most new companies from outside the region?
- Are the founders typically from the region or people who have moved to the area to start a business?
- Do networks play a role in business formation in your region? If so how?

New Venture Support (to be asked of business respondents and venture capitalists)

- Is there a strong group of local business support and strategic advising services for start-ups? How have they been helpful to you?
- What alliances or networks provide access to capital?
- How rapidly can new ventures or expansions be financed locally?
- Does the regional culture foster start-up ventures and entrepreneurship? If so, how?
- How does government in your area support the particular needs of start-up companies? (Incubators, financing, enterprise zones?)

Venture Capital (VC)/Financiers Sector

- What is your primary source of deal flow? (Is it network related?)
- How does the VC define its role in an investment relationship (e.g., develop team, strategic/expert advisor, connect firms to talent and technology-matchmaker)?
- Apart from actual deals, what are the most prominent ways you are connected to the business community?

Please have the respondent indicate yes or no to the following questions and then explain his or her answer:

- Do you have formal and/or informal relationships with other VCs?
- Do you have linkages with University R&D community? Points of connection? Incubators? Technology licensing offices? Are the relationships formal/informal?
- Do you have involvement in industry associations?
- Is there an "angel" community providing seed capital where traditional VC does not? Does your VC follow up as the project matures?