The Development of a Methodology for Measuring the Effect of Broadband Quality on SME Performance

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by

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Abstract

This thesis develops a methodology for ascertaining any variation of economic impact in Small to medium-sized enterprises (SMEs) through varying quality of broadband provision, and applies the chosen methodology in order to measure any impacts and to analyse the results of the research study.

The research focuses on businesses within the Cardiff and Ceredigion Local Authority areas of Wales, representing the most urban and most rural regions of the nation. These areas were chosen in order to ascertain whether a divide exists in the provision of broadband between urban and rural areas and what impact, if any, this has on businesses in these areas. Indices for measuring the quality of a broadband connection and for the economic impact of broadband upon SMEs are created and applied to the survey results collated from participating businesses.

The study establishes SME attitude toward broadband provision, indentifying the importance of broadband to SMEs and their desire for improved quality broadband provision. The study fails to identify a clear direct link between broadband quality and economic impact at this time, but argues that this may not be the case in future since low take-up of higher quality broadband services by businesses presently resulted in less variation in broadband quality than anticipated. However, the research does establish that many SMEs have issues of awareness, skills and knowledge with regards to the use of their broadband connection that is restricting their ability to fully utilise the potential that broadband connectivity provides.

The thesis concludes by exploring the regulatory and policy implications arising from the research, particularly in light of recent developments in the subject area. Further research opportunities are also noted and suggestions are made on how the research methodology used in this study could be adapted and improved for future use.

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Finally, my thanks are due to my parents, Tony and Ann, and to my sister Angharad Mair for their support and patience throughout the course of this research.

Dedication

To my parents, thank you so much for your love, support and kindness. You have my love and gratitude always.

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List of Abbreviations

ADSL Asymmetric digital subscriber line
ADSL2+ ADSL download speed up to 24 Mbps

BAP Budget Allocation Process
BERR Department for Business, Enterprise and Regulatory Reform
BDUK Broadband Development UK
BIS Broadband Index Score
BQS Broadband Quality Score

CapEx Capital Expenditure
CDMA Code Division Multiple Access

DCMS Department for Culture, Media and Sport
DNS Domain Name Server
DSL Digital subscriber line

EE Everything Everywhere
EDI Electronic Data Interchange
EIS Economic Impact Score
ERDF European Regional Development Fund

FTTC Fibre-to-the-cabinet
FTTH Fibre-to-the-home
FTTP Fibre-to-the-premises
FWA Fixed Wireless Access

GDP Gross domestic product
GDHI Gross Disposable Household Income
GPRS General Packet Radio Services
GVA Gross value added

HTTP Hypertext Transfer Protocol

IaaS Infrastructure-as-a-Service
ICT Information and Communications Technology
IPTV Internet Protocol Television
ISDN Integrated Services Digital Network
ISP Internet Service Provider

LA Local Authorities
LINC Local Intelligence Network Cornwall
LLU Local loop unbundling
LTE Long term evolution

NGA Next generation access
NGF Next generation fund

OFCOM Office of Communications
OECD Organization for Economic Co-operation and Development

PaaS Platform-as-a-Service
PoP Point of Presence
PSTN Public Switched Telephone Network

RIBS Regional Innovation Broadband Support
R&D Research and Development

SaaS Software-as-a-Service
SDSL Symmetrical Digital Subscriber Line
SEWEF South East Wales Economic Forum
SME Small and Medium sized Enterprises
SMS Short Message Service

TCP Transmission Control Protocol
TDMA Time Division Multiple Access

UNESCO United Nations Educational, Scientific and Cultural Organization
USC Universal Service Conditions
USD Universal Service Directive

VANs Value Added Networks
VADs Value Added Services
VDSL Very-high-bit-rate digital subscriber line
VoIP Voice over Internet Protocol

WAP Wireless Application Protocol
WEFO Wales European Funding Office
WLGA Welsh Local Government Association

2G Second generation wireless telephone technology
3G Third generation wireless telephone technology
4G Fourth generation wireless telephone technology
21CN 21st Century network programme.

Chapter 1 - Introduction

1.1 Introduction.

This chapter provides an introduction to the thesis by explaining the disparity in telecommunication services, and therefore broadband services, between urban and rural areas; the importance of SMEs (Small to Medium Size Enterprises) to the Welsh economy; the importance of the digital economy and its dependence upon broadband quality; and the research aims, together with the research structure, contained within this thesis.

This thesis considers the importance of broadband services to SMEs and the unavailability of common standards of broadband services between rural based SMEs and their urban located counterparts. The problems encountered by rural companies, through lack of comparable services, are considered, as well as Government plans to redress the problem in future years. The existing telecommunication network in Wales is described in order to provide an insight into the problems in delivering ubiquitous service level of broadband to the business community, together with a description of the economic and geographic landscape of Wales in order to appreciate the broadband needs of the rural areas and the problems of delivering such services.

The thesis then moves on to give an analysis of the SME marketplace, building the evidence to support why SMEs are considered to be so important to the Welsh economy and showing the significant proportion that SMEs contribute to employment and private sector turnover in Wales. Furthermore, SMEs are also analysed from a UK and European perspective in order to show how the contribution of SMEs varies between Wales and broader geographic marketplaces. The thesis also considers the different definitions given for an SME and includes a definition of an SME as used throughout this study.

A methodology is developed to indicate the broadband quality and its economic impact upon SMEs which are based in rural and urban area of Wales. A study of SMEs is carried out by questionnaire and case interviews, and the methodology is applied to the results of the questionnaire. Finally, considerations are given to the results, with recommendations for future research, particularly with the on-going development of the broadband infrastructure in mind.

1.2 Background

'Broadband' is a term borne from the rapidly merging sectors of communications and information technology, known as information and communications technologies (ICT). In general, broadband refers to a telecommunication technology whereby a wide band of frequencies is available for directly communicating information in the form of data, video, voice and graphical representations.

The use of telecommunication services by businesses prior to the early 1990s was limited to voice communications, telex and fax services using the Public Service Telecommunication Network (PSTN), with data services used by large companies deploying relatively expensive private data networks, certainly prohibitively expensive for SMEs.

The advent of Integrated Service Data Networks (ISDN) enabled a greater number of small businesses the use of digital services as this became available for PSTN users. However, this service was still costly for SMEs and resulted in low take-up.

Prior to public and business use of the Internet, use of data communications by businesses was limited mainly to Electronic Data Interchange (EDI), a form of electronic trade document exchange from business-to business and from business-to- government e.g. customs and excise."EDI is a new way of conducting business" (Nelson, 1990); "EDI is all about moving data reliably, quickly and with predictability from system to system" (Berge, 1991). But at the beginning of the 1990's moving data between computer/business systems was achieved by using Value Added Networks (VANs) or Value Added Services (VADs),"services based on telecommunication networks with added value above and beyond basic conveyance" (M Gifkins, 1988). These networks were therefore the narrow band fixed line copper based networks with additional services at an additional cost.

As Internet use became available to the wider public, commercial transactions from business-to-consumers became more prevalent. However, early use of the Internet, particularly the World Wide Web, for searching for information and for the creation and use of simple websites for business advertising had limited success and created much frustration due to a lack of adequate bandwidth, resulting in slow web browsing speeds and unreliable service.

As a result of this frustration and the obvious emerging potential of online trading, a first generation of broadband services was introduced for the provision of faster and more reliable Internet access.

It is more than forty years since J.C.R. Licklider and Robert W. Taylor stated that “in a few years, men will be able to communicate more effectively through machine than face to face” (Licklider and Taylor, 1968), and whilst this may have taken longer than their perceived ‘few years’, thanks to broadband networks their vision is now close to being realised.

Broadband is an access technology that enables end users to use a variety of applications and services. Consequently, its value to businesses is derived from the use of these applications and services rather than through access to broadband itself.

During the World Summit of the Information Society in December 2003 (WSIS, 2003), global heads of state and government declared a challenge of building a society where everyone can access and share information, enabling individuals, businesses and communities to achieve their full potential in promoting their development and improving quality of life. The commitment was reaffirmed during the second phase of the summit in November 2005 (WSIS, 2005).

In order to achieve this goal, a number of hurdles must be overcome. These hurdles include the extreme disparities in access to information and communication technologies both between and within nations, i.e. the ‘digital divide’.

According to the Organisation for Economic Co-operation and Development (OECD), there is little doubt that information and communication technology has promoted profound economic and social change over the past decade or so. The need for statistics and analysis to support and inform policy-making has grown alongside the rapid emergence of new ways of communicating, processing and storing information, (OECD, 2009).

“There is a growing debate about the meaning and impact of broadband. Research has to go beyond analysing just the number of broadband subscriptions – which are defined as an Internet connection providing the user with a minimum downstream speed of 256kbps – and examine other factors, such as speed and quality of service. These issues are particularly relevant since there are signs that the world is facing a growing divide in terms of broadband speed and quality”, (ITU, 2011).

High levels of rural population, older inhabitants and low income households all provide barriers to basic ICT and, ultimately, broadband penetration levels. Wales, Scotland and Northern Ireland all have higher rural populations than England, with Wales and Northern Ireland having particularly

high rural populations at 22% and 35% of their respective populations. However, the 'E-communications household survey' (Commission E. , 2011), conducted on behalf of the European Commission, reported that, for the EU-15 group of countries as a whole, broadband take-up levels were not dependent upon urbanisation.

Furthermore, the survey's analysis shows that household size has a greater influence upon broadband take-up; the more people there are in a household, the more likely it is that it will have a broadband connection.

	Wales	England	Scotland	Northern Ireland	UK Total
Rural population	22%	13%	16%	35%	12%
Older people (aged 65 plus)	18%	16%	16%	14%	16%
Household Income Under £11,500	43%	26%	32%	29%	27%
Source: ONS and Business Geographic 'Urban Indicator'					

Table 1.1 – Profile of socio-economic groups in UK nations, 2011

As shown in Table 1.1, the ONS report that Wales also has particularly high numbers of households with an income of under £11,500 when compared to the other nations at 43% of all households and high numbers of people aged over 65 compared to the UK total. As such, Wales has the greatest socio-economic barriers to overcome out of the four UK nations with regards to broadband take-up (ONS, 2005).

Although barriers to rural economic growth are dependent on many factors, two major barriers are distance and lack of economies of scale (due to smaller market sizes) (Parker, 2000). Telecommunications infrastructure, particularly broadband, can neutralize both of these problems and level the competitive playing field between urban and rural businesses.

Wales is considered a disadvantaged nation in terms of a ubiquitous broadband service. In 2010, Ofcom (Office of Communications) reports that 64% of the Welsh population has access to some form of broadband service compared to 73% across the UK, with cable broadband (i.e. higher speed or superfast broadband) availability of 23%, compared to the UK figure of 48%. The report quotes "people who live in rural locations are less likely to have access to superfast broadband, a 3G phone

(i.e. a phone with broadband capabilities) signal, and a choice of suppliers through their local fixed telephone exchange". It is also noted that average broadband speeds are lower in rural areas than in urban areas because of the lack of cable services (Ofcom, 2011). In 2011 broadband take-up in Wales had increased to 71% compared to the UK figure of 74% but penetration was higher in urban areas at 72% than in rural areas at 67%, with cable availability still on 23% with Wales the second lowest region in the UK with fibre-to-the-cabinet (FTTC) superfast broadband connections at 14%, predominantly in urban areas (Ofcom, 2011). In 2012, Ofcom reported "during the course of 2011, broadband take-up in Wales remains at 71%, but differences by area and demographics still exists – Wales has the lowest household availability of superfast broadband services across the UK nations in March 2012 at 34% - this was because cable broadband availability [continues at 23%] was the lowest among the UK nations and FTTC availability [17%] the second lowest after Scotland" (Ofcom, 2011). Wales has the greatest number of SMEs with the lowest adoption of digital channels for business use (Lloyds Banking Group, 2012). This thesis will therefore consider the disparities of broadband services that exist within Wales, concentrating on the differences in accessibility between rural and urban areas but also considering the differences within those areas.

1.3 Importance of Digital Capacity in Rural Areas.

Despite consistent evidence of a substantial return on investment to the economy as a whole, the internal return of investment to those installing new rural infrastructure is often too small to justify the initial investment. This is because the users of advanced services, not the providers, capture many of the economic benefits of improved telecommunications, i.e. the external return greatly exceeds the internal rate of return. Consequently, the fundamental economic problem in rural telecommunications is the ability to aggregate sufficient demand to make it economically viable for any provider to make the initial investments, (Parker, 2000).

There exists plentiful demand from residential and business consumers to justify infrastructure investment within urban areas. Rural communities require the same services that are available in urban areas, if not more, in order to overcome the problems of distance and choice. However, the disparity in telecommunications services between urban and rural areas, or the 'digital divide', is very real and is continually increasing, particularly as high-speed Next Generation Access (NGA) becomes available in urban areas before roll-out to the rural areas.

1.4 Importance of Broadband Quality

The diffusion of ICT is affected by the price of access and use, the quality of the services, and the expected profitability of its use in business or the welfare gains of households. Likewise, infrastructure influences diffusion: e.g., the Internet cannot be accessed without telecommunications networks and e-commerce requires secure servers (Cuervo, 2006).

Varying broadband quality is a particularly important issue in Wales because the high proportion of rural homes and businesses, and the challenging topology of Wales mean that many homes do not have access to good quality broadband services, compared to other areas of the UK.

High-speed broadband is very expensive to deploy, even more so in rural areas due to the long distances of properties from their local exchanges. Anecdotal evidence exists in Wales of communities and individuals in rural areas who have attempted to obtain a broadband connection and have been quoted costs that are far beyond the means of the average SME. These costs can range from £56K to individuals who require BT to install a dedicated broadband connection to £550K for villagers who required their locality to be connected to a network capable of providing broadband to 80 households.

To ensure that all premises across Wales, and the UK, have a good quality broadband connection, at affordable prices, it will be necessary for government to intervene and provide support, financial and legislative, particularly in the rural areas. This will be important in providing economic benefits to Wales, and will be explored further in this thesis.

1.5 Research Aims

Through analysis of the impact of broadband access upon business functions within SMEs, this thesis aims to develop a methodology for measuring the effect of broadband quality on SME Performance by:

- Providing evidence as to what degree the quality of broadband service provision differs between SMEs located in urban and rural areas of Wales; and within these areas considering the effect of broadband quality upon SME performance;

- Providing evidence on whether rural SMEs are disadvantaged by the lesser quality of broadband access that is available to them;

- Considering regional policy approaches by government in order to improve digital access by all SMEs, particularly rural businesses.

This thesis addresses the issue of the lack of knowledge of the varying quality in broadband provision across Wales and the impact that this has upon the nations SMEs. Relevant agencies have found it very difficult to obtain information about the benefits of broadband access, particularly on an economic basis. Therefore, this thesis analyses the issues and provides evidence of the benefits of broadband access for SMEs.

1.6 Thesis Structure

The structure of the thesis is as follows:

- Chapter 1 has provided a brief introduction to the importance of broadband as a key economic enabler and that the quality of service is not consistent across the UK and particularly Wales where rural areas are disadvantaged.

- Chapter 2 provides an analysis of the SME marketplace, highlighting the importance of SMEs to the Welsh economy. This chapter also examines the importance of ICT to SMEs, with particular focus upon the value of the internet to the economy. The chapter also considered the urban-rural divide in Wales and how it impacts upon SMEs.

- Chapter 3 investigates the policy measures for broadband infrastructure support in the EU, UK and Wales. This is completed through the analysis of various surveys and literature obtained through an extensive search of strategy documents from EU governance level down to local authority level, a search of academic work on broadband deployment and through a search of numerous other research and technology related websites, as well as through the attendance of various conferences. The chapter also considers new initiatives to introduce superfast broadband across the country and presents examples of international studies on the impacts and benefits of broadband at national and regional levels.

- Chapter 4 describes the telecommunication landscape in Wales, detailing how it compares to the UK as a whole and considers the difference between urban areas, with an emphasis on broadband services. This is achieved through the analysis of a number of reports from the communications regulator (Ofcom) and a number of leading market research organizations and Government reports. In particular it highlights the significant differences in broadband provision between Cardiff and Ceredigion, the two areas chosen for further study in this thesis.

- Chapter 5 provides an economic and demographic profile of two regions in Wales chosen for the research, one rural and the other urban, providing details on the geographic characteristics, business and labour statistics, and socio-demographic statistics. This is achieved through secondary research, including the analysis of a number of surveys.

- Chapter 6 sets out the methodology adopted in this thesis. This includes an explanation of why a mixed method survey and case study methodology was chosen and includes the development of a model showing how SMEs benefit from the use of broadband which will be used as the basis to formulate the SME survey and for analysing the questionnaire results. This enables the development of an index for measuring the economic impact (EIS) that broadband has upon SMEs.

  Chapter 6 also sets out the methodology used to create an index (BIS) for measuring the quality of broadband services, utilising an experts' survey for weighting the importance of the different quality parameters of a broadband service to SMEs. This enables us to test the key hypothesis underlying the research, namely that there is a positive relationship between the quality of broadband service and the economic impact of broadband upon SMEs.

- Chapter 7 provides an in-depth study on the impact of broadband on SMEs. This includes a survey of relevant experts to determine the weighting for the BIS index to measure the quality of a broadband service and to gather their opinion on the importance of different quality parameters of a broadband service to SMEs.

  The chapter also includes a survey of SMEs located in the rural and urban chosen regions to ascertain their perception of the economic impact that broadband has had on their business, and examines the relationship between the EIS and BIS scores for each firm. This will be

followed by in-depth case studies of some of the SMEs in both regions that took part in the survey.

The chapter concludes with an analysis of both surveys and the case studies.

- Chapter 8 concludes the research programme and thesis. The findings of the research study are summarised, with particular attention given to any contrast in the importance of broadband to SMEs between the two regions. The ongoing importance of broadband and SMEs to the economy are addressed and considerations are made for policymakers and regulators as to how they can support SMEs in the provision and use of broadband.

  The contribution to knowledge and the limitations of the research are noted, along with identification of further research opportunities presented by the research analysis.

Chapter 2 – SMEs, ICT and the Urban-Rural Divide

2.1 Introduction

This chapter provides an analysis of the SME marketplace, building the evidence to support why SMEs are considered to be so important to the Welsh economy and showing the significant proportion that SMEs contribute to employment and private sector turnover in Wales. Furthermore, SMEs are also analysed from a UK and European perspective in order to show how the contribution of SMEs varies between Wales and broader geographic marketplaces. The chapter also considers the different definitions given for an SME and includes a definition of an SME as used throughout this thesis.

The chapter continues by examining the importance of ICT to SMEs and also considers the impact of the urban-rural rural divide upon SMEs.

2.2 Importance of SMEs in the Economy

This thesis intentionally concentrates on the SME sector due to the fact that SMEs are critically important to the Welsh economy and that there is little research focused upon telecommunications needs in SMEs, both in Wales and on a broader scale. The main focus of current research on future developments in telecommunications is the needs of consumers. However, telecommunications have a daily impact upon most SMEs and, as such, it is extremely important that their needs are considered when designing any new infrastructure.

2.2.1 Definition of a Small to Medium-sized Enterprise

The definition of an SME used by the Department for Business, Innovation and Skills is a business with less than 250 employees (BIS, 2005), although the department notes that there is no one definition for a small enterprise. Other commonly used definitions also take turnover and balance sheet information into account.

	Turnover	Balance Sheet Total	Number of Employees
Small Company	Not more than £5.6 million	Not more than £2.8 million	Not more than 50
Small Group	Not more than £5.6 million net (or £6.72 million gross)	Not more than £2.8 million net (or £3.36 million gross)	Not more than 50
Medium-sized Company	Not more than £22.8 million	Not more than £11.4 million	Not more than 250
Medium-sized Group	Not more than £22.8 million net (or £27.36 million gross)	Not more than £11.4 million net (or £13.68 million gross)	Not more than 250
Source: Department for Business, Innovation and Skills			

Table 2.1 – Definitions for an SME, 2004

Section 247 and 249 of the Companies Act of 1985 (Amendment 2004) state that a company (or group) qualifies as a small or medium-sized company (or group) if it meets two out of three criteria relating to turnover, balance sheet total and number of employees, as set out in Table 2.1, within its first financial year, or in the case of a subsequent year, in that year and the preceding year.

The definition of an SME used by the European Union varies somewhat from that used by the Department for Business, Innovation and Skills. On 6 May 2003, the European Commission adopted a new recommendation regarding the SME definition which replaced the previous recommendation on 1 January 2005 (EC, 2003).

Within this recommendation an enterprise was defined as:

'An enterprise is considered to be an entity engaged in an economic activity, irrespective of its legal form. This includes, in particular, self-employed persons and family businesses engaged in craft or other activities, and partnerships or associations regularly engaged in an economic activity.'

Further to this, micro, small and medium enterprises were categorised as:

'The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.'

'Within the SME category, a small enterprise is defined as an enterprise that employs fewer than 50 persons and whose annual turnover and/or annual balance sheet does not exceed EUR 10 million.'

'Within the SME category, a micro enterprise is defined as an enterprise that employs fewer than 10 persons and whose annual turnover and/or annual balance sheet does not exceed EUR 2 million.'

This thesis will adopt the definition used by the Department for Business, Innovation and Skills as much of the information relating to SMEs in this thesis is sourced from the ONS which uses the department's definition.

2.1.2 SMEs in Europe

There were 19.6 million SMEs in the EU-27 non-financial business economy in 2005, as shown in Table 2.2. The importance of SMEs in Europe is evident by the fact that they account for 99.8 % of all businesses. Furthermore, SMEs account for more than two-thirds (67%) of employment in the non-financial business economy and more than half (58%) of value added, providing 85 million jobs and more than EUR 3,000 billion in value added (Eurostat, 2006).

	Total	SMEs	Micro 0-9	Small 10-99	Medium 100-249	Large 250+
Number of Enterprises (millions)	19.65	19.60	18.04	1.35	0.21	0.04
Percentage Share	*100.0*	*99.8*	*91.8*	*6.9*	*1.1*	*0.2*
Persons Employed (millions)	126.7	85.0	37.5	26.1	21.3	41.7
Percentage share	*100.0*	*67.1*	*29.6*	*20.6*	*16.8*	*32.9*
Value Added (EUR billion)	5,360	3,090	1,120	1,011	954	2,270
Percentage share	*100.0*	*57.6*	*20.9*	*18.9*	*17.8*	*42.4*
						Source: Eurostat

Table 2.2 – Number of enterprises, persons employed and value added by enterprise size in EU, 2010

2.1.3 SMEs in Wales and the UK

As shown in Table 2.3, there were an estimated 175,460 SMEs in Wales in 2010 which represents 99.9% of all enterprises in the country. Furthermore, SMEs accounted for more than three-quarters of all employment (76.5%) and three-fifths (62.2%) of turnover, (ONS, 2011).

	Number of enterprises	Percentage share of all enterprises				Total employment (thousands)
		Micro 0-9	Small 10-99	Medium 100-249	Large 250+	
Wales	*175,460*	*95.8*	*4.0*	*0.2*	*0.1*	*703*
England	3,775,015	95.6	4.0	0.2	0.2	19,426
Scotland	276,630	94.9	4.7	0.2	0.2	1,507
Northern Ireland	114,940	94.3	5.4	0.2	0.1	495
Source: Department for Business, Innovation and Skills						

Table 2.3 – Breakdown of Enterprises in the UK, 2010

In 2012 the number of SMEs in Wales had risen to 210,700, employing an estimated one million people. Of the 99% of these businesses, 95% are classed as micro-businesses employing up to 9 people (Davies, 2012). Table 2.4 indicates that SMEs accounted for more than three-quarters (76.6%) of total employment and more than three-fifths (62.1%) of all turnover in Welsh businesses. These figures are both considerably greater than those for England and Scotland and, thus, emphasises the particular importance of smaller enterprises to the Welsh economy.

	Number of enterprises	Percentage share of all employment				Total employment (thousands)
		Micro 0-9	Small 10-99	Medium 100-249	Large 250+	
Wales	*175,460*	*44.0*	*25.1*	*7.5*	*23.5*	*703*
England	3,775,015	31.8	13.9	11.6	42.7	19,426
Scotland	276,630	31.8	21.6	7.4	39.3	1,507
Northern Ireland	114,940	41.6	30.5	8.7	18.9	495
Source: Department for Business, Innovation and Skills						

Table 2.4 – Breakdown of employment in the UK, 2010

It is often argued that SMEs in rural areas are under a disadvantage relative to those in urban areas, but the issues that they face are not well understood (Smallbone and North, 1999). Limited evidence exists on their characteristics and on whether they face different barriers to growth than their counterparts in urban areas. This is particularly true for SMEs in rural Wales where low population density means that studies from other parts of the UK often cannot be generalised to rural Wales and problems often arise due to statistics not being available that allow the separation of data between urban areas and rural areas. However, as the evidence base for rural Wales improves, it is increasingly apparent that there are noticeable differences between rural and urban Wales. These issues have important implications for the Welsh Government when developing and implementing policies.

SMEs in rural areas may experience competitive disadvantage relative to urban SMEs arising from a variety of issues. These may include limited access to business services and finance, low availability of labour and property and poor transport infrastructure (Fuller-Love et al., 2006).

Some of the factors affecting the performance of SMEs in rural areas reflect the characteristics of the wider rural economy. Low incomes are a key policy problem for rural areas (Fuller-Love et al., 2006) and rural Wales is characterised by low employment growth, a high reliance on self-employment and a lack of dynamic economic sectors. Wages in rural Wales are lower than the Welsh average, reflecting the type of jobs that are available within the rural economy.

The importance of manufacturing, although not as important to rural compared to urban areas, has declined in recent years and agriculture is also declining in terms of economic importance. Jobs provided by tourism and other services are often part-time or seasonal. Consequently, there is significant dependence on public sector employment.

Rural firm growth is limited by a number of factors, including limited scope of local demand and poor access to extra-regional markets, low density and consequent lack of opportunity for networking, inadequate access to and unfamiliarity with modern information technology, and difficulties in accessing capital (Fuller-Love et al., 2006).

Whilst evidence exists regarding many factors that may disadvantage rural SMEs (Anderson et al. 2005; Buss and Lin 1990; Smallbone et al. 2003), there is little research focused upon

telecommunications needs of SMEs, either in Wales or on a broader scale. It is important that such evidence be gathered since the geography of Wales has a great influence on the settlement pattern and communication routes and, as such, significant differences can exist in the service level provision of telecommunications services between geographical areas. The main focus of current research on future developments in telecommunications is the needs of private household consumers; however, telecommunications has a daily impact upon most SMEs and their specific business needs should be considered.

According to van der Ploeg and Renting (2000), the economic success of some rural areas relies on diversification, the development of clusters and the adoption of new technologies. Communications technology is seen as important as it can provide access to global markets for rural SMEs (Smallbone and North, 1999). North et al. (1997) found that small businesses in rural areas tend to be less innovative and slower to adopt new technology. As such, poor telecommunications infrastructure could provide a major barrier to rural business growth and the economic success of rural SMEs.

According to the Global Entrepreneurship Monitor (Jones-Evans, 2004, p.6) around 80 per cent of the start-ups and new firms in Wales have no degree of exports and falls behind many other regions in terms of the export orientation of its start-up companies. This is an area where more emphasis may be required in the support given to certain start-ups, increasing the knowledge of exporting services in Wales. However, the degree to which 'exporting' per se is possible is largely determined by both the nature of start-up in a particular sector and the ambitions of the entrepreneur. Creating new and growing businesses that see their market as more than their immediate locality must be a primary objective of business support services and this is an area that can be assisted through broadband access which allows small businesses to access global markets that would have previously been beyond their reach.

2.2 Importance of ICT to SMEs

There is much evidence that information and communication technologies (ICTs) are drivers of economic growth. As a result, government is keen to promote ICT take-up, particularly where there is economic development need.

The Internet economy[1] is an important issue for all nations and regions as electronic trading is becoming increasingly popular. It is also dependent on the accessibility of broadband and this can therefore affect the economic viability of geographic regions. The actual value of the internet economy varies between various organisations. The Boston Consultancy Group indicates that the measurable size of the UK Internet economy in 2009 was £100 billion, or roughly 7.2% of Gross Domestic Product (GDP). This share is larger than the country's construction, transportation or utilities industries. It is likely that the UK Internet economy will continue to grow by 10% year on year, reaching 10% of GDP by 2015, or potentially up to 13%. This makes the United Kingdom the world's leading country for e-commerce and UK businesses are using the Internet to expand their sales overseas. The United Kingdom is now a net exporter of e-commerce goods and services, exporting £2.80 for every £1 imported. This is the opposite of the trend seen in the offline economy, which exports 90p for every £1 imported. (BCG, 2010) Another estimate by Vodafone UK shows that the UK internet economy is worth £82B in 2012, with £37B in the internet value chain and £45B in the e-commerce it supports. The value chain is 2.6% of the UK's GDP, while e-commerce is a further 3.1%. The report states that "the UK has a much stronger business-to-consumer e-commerce sector than other countries with the proportion of business-to-business e-commerce to GDP triple the global average" (Kearney, 2012, p. 67).

Around 62% of all adults bought goods or services online in 2010 with a collective spend of around £50 billion. This is an increase from just £2 billion in 2001. In 2011, strong performances came from the clothing, health and beauty, alcohol and home and garden sectors, raising consumer spending to an estimated £76bn shopping online. Electrical items, gifts and travel products bought online fared less well. While online clothing sales have consistently performed well, sales have in fact slowed over the past few months. Sales via mobile devices also gained momentum, growing from 0.4 per cent of e-retail sales at the start of 2010, to 5.3 per cent this year. The study also found that 2.6 per cent of visits to e-retail sites were through mobile phones in 2010, increasing to 8.2 per cent in 2011. (IMRG, 2012). If the Internet economy was a separate industry sector it would be the fifth largest in the UK.

Several studies have provided empirical evidence, informed commentary and detailed analysis of issues concerning rates of adoption of ICT in rural firms, potential benefits of ICT use for rural economies, barriers to adoption in rural small- to medium-sized enterprises (SMEs), and critiques of policy interventions aimed at promoting ICT use. Despite these studies, however, commentators

[1] The Internet Economy refers to conducting business through markets whose infrastructure is based on the Internet or the World Wide Web (economyweb).

have noted that there is a lack of cohesion in understanding of issues relating to and affecting ICT use in rural areas particularly (Galloway and Mochrie, 2005).

	Number of employees			
	10-49	50-249	250-999	1,000+
Internet Access	95.3	99.5	98.6	99.7
Broadband	93.8	98.6	98.3	99.5
Mobile Broadband using 3G	52.8	79.0	91.0	97.5
				Source: ONS

Table 2.5 - Proportion of businesses (%) with Internet access and type of connection, by size of business, 2012

In 1998 Buhalis and Main (1998, p. 201) noted that ‘‘the internet is gaining commercial viability and is particularly suited to small business, where it enables [them] to keep doors open 24 hours a day, at minimal cost to customers all over the world’’. Since that time internet adoption by businesses has increased significantly and, as Table 2.5 shows, the the vast majority of businesses now have internet access, and the majority of them have broadband. Whilst internet and broadband adoption do increase with business size, even small businesses have high levels of adoption as evidenced by 95.3% of businesses with 10-49 employees now having internet access.

This thesis considers the impact of varying quality of broadband services upon SMEs. One key parameter of broadband quality is download speed and Table 2.6 shows a trend towards the adoption of higher speed services as businesses using services with headline speeds of 10Mbps or less decreasing in almost all band sizes between 2010 and 2012, whilst adoption of services with greater headline speeds than 10Mbps has increased for almost all band sizes. However, whilst there are increases across all band sizes, there is a significant difference in the number of firms adopting higher speed services, with larger businesses far more likely to have higher speed services than smaller businesses. Fewer than 15% of businesses in the 10-49 employees band had a 30Mbps+ service, compared to more than 60% of businesses with 1,000+ employees. It must also be noted that these are the headline advertised speeds of services and not the actual speeds achieved on business premises.

		Employment size				
		10 - 49	50 - 249	250 - 999	1000+	**All sizebands**
Less than 2Mbps	2010	11.9	5.6	5.3	2.0	**10.8**
	2011	7.9	5.0	3.3	0.1	**7.3**
	2012	8.3	5.1	1.3	0.4	**7.6**
2Mbps or more, and less than 10Mbps	2010	46.4	49.1	47.0	24.8	**46.7**
	2011	45.9	43.9	33.9	17.7	**45.1**
	2012	43.5	38.1	25.5	12.8	**42.1**
10Mbps or more, and less than 30Mbps	2010	20.7	23.4	22.2	28.4	**21.2**
	2011	23.9	28.0	31.5	28.5	**24.7**
	2012	25.0	30.5	32.8	24.4	**26.0**
30Mbps or more, and less than100Mbps	2010	4.4	6.9	11.0	19.8	**5.0**
	2011	6.4	10.2	14.2	19.8	**7.3**
	2012	9.4	12.2	18.7	22.6	**10.1**
100Mbps or more	2010	3.4	9.7	11.5	23.1	**4.6**
	2011	4.5	8.7	14.3	32.0	**5.6**
	2012	4.5	9.8	18.8	38.4	**5.8**

Table 2.6 - Proportion of businesses by maximum contracted Internet connection speed, by size of business, 2010 to 2012

With access to increasing markets throughout the world, businesses, including those in rural areas, have a unique opportunity to expand either business-to-business, or business-to-consumer, operations from the traditional and local, to the global (Reynolds, 2000; Amit and Zott, 2001; Lawson et al., 2003). Whether a firm trades online with customers or not, however, the internet can give firms the advantage of increased profile in that it can allow them to present information to potential customers (Tse and Soufani, 2003), and provide another channel for the purposes of brand building (Jacobs and Dowsland, 2000), advertising, and marketing (Turban et al., 2000).

	Number of employees			
	10-49	50-249	250-999	1,000+
Website	79.6	92.9	95.9	98.8
				Source: ONS

Table 2.7 – Proportion of businesses with a website, 2012

The Internet is paying dividends for SMEs. Online sales for SMEs grew 43% annually from 2004 to 2008 and, as shown in Table 2.7, the majority of businesses have their own website (ONS, 2012). However, according to Google (BCG, 2010), 40% of small businesses in Wales still do not have a website and, given that 97% of consumers are now using the Internet to research products and services in their local area, many businesses in Wales are missing out on this Internet boom. This is a trend that needs to be reversed if businesses based in Wales are to compete with the rest of the UK in this rapidly growing sector. Only 58% of Welsh SMEs were classed as high-web users by Google, compared to 66% for the UK as a whole, making Wales the third lowest region after Northern Ireland and the North East of England.

	Sales over a website	Sales over EDI	Total e-commerce sales
10-49 employees	0.7	0.3	1.1
50-249 employees	0.7	1.4	2.1
250-999 employees	1.5	4.2	5.8
1000+ employees	3.1	6.2	9.3
			Source: ONS

Table 2.8 – Proportion of business turnover derived from e-commerce sales (%), by size of business, 2012, ONS

Table 2.8 shows that smaller businesses are deriving far less turnover from ecommerce sales than larger businesses. With only 1.1% of turnover in businesses with 10-49 employees and 2.1% in businesses with 50-249 employees coming from e-commerce compared to 9.3% in businesses with 1,000+ employees, there is clearly still potential for growth in this area.

The ability of firms to develop relationships with customers via customer information gathering and personalised marketing further affords advantage to business, and particularly small businesses (Anderson and Lee, 2003). As Baourakis et al. (2002, p. 582) point out:

. . . using the proper internet technology, companies can gather information from consumers . . . this helps companies to improve the quality of products, to develop new products and adopt an attitude of flexible response to the wants and needs of their potential customers.

It also affords:

. . . the ability to build customer profiles and, consequently, to establish dialogues with individual customers . . . [which] . . . helps firms to improve target marketing and to create Web-based personalisation (Baourakis et al., 2002, p. 584).

However, as shown in Table 2.9, far fewer smaller businesses are engaging in social media than larger businesses and, consequently, are failing to make use of the advantages that they afford.

	10 - 49	50 - 249	250 - 999	1000+	**All sizebands**
Any social media	**41.8**	**54.9**	**66.2**	**81.2**	**44.5**
Type of social media:					
Social networks	40.3	53.3	63.2	79.4	**42.9**
Business blogs or microblogs	21.6	32.3	42.9	61.9	**23.8**
Multimedia content sharing websites	13.1	21.7	33.5	49.7	**15.0**
Wiki based knowledge sharing tools	5.8	7.1	17.1	26.4	**6.4**

Table 2.9 – Proportion of businesses using social media, by size of business, 2012, ONS

Electronic business and electronic commerce present many opportunities for businesses to improve their performance (Tetteh and Burn, 2001). In 2002 the UK government acknowledged that there was a slow takeup of e-commerce amongst SMEs, particularly amongst micro-businesses (UK Online, 2002). The main reasons cited were ignorance about e-commerce benefits and a shortage of the appropriate skills (DTI, 2002). Meanwhile, Darch and Lucas (2002) found several perceived barriers to the adoption of e-commerce in Australian SMEs including costs, lack of awareness of what e-commerce involves, lack of e-commerce skills, lack of knowledge, lack of help and lack of time. Secondary issues were inadequate telecommunications infrastructure, lack of trust and the relevance of e-commerce to their particular industry sector. Chappell et al. (2002) state that a lack of SME bespoke information is why many SMEs are not taking advantage of the Internet. Lawson et al. (2003) suggest that the barriers can be categorised as either technical or social factors and provides further evidence in

Australian SMEs for lack of skills, knowledge and poorly trained staff. Most of the barriers identified by Lawson et al. (2003) were non-technical and they suggested some ways in which these barriers may be overcome such as government and industry associations providing information to raise. Many SMEs may be left behind while the larger companies advance and dominate in the e-commerce world. However, as Table 2.10 shows, e-commerce sales by businesses of all size bands are increasing in the UK, although the proportion of e-commerce sales do increase significantly as business size increases. It will be interesting to see whether the technical barriers, such as varying broadband quality, are now more prevalent or whether social barriers are still more prevalent despite the years that have passed and the opportunities for overcoming them.

			Employment size				
			10 - 49	50 - 249	250 - 999	1000+	**All sizebands**
Sold over website	2008		11.3	17.0	26.3	33.0	**12.7**
	2009		12.3	20.3	24.6	38.7	**14.0**
	2010		12.8	22.6	21.9	41.1	**14.7**
	2011		14.7	22.9	25.2	44.5	**16.4**
	2012		17.1	23.2	30.3	47.2	**18.5**
		to the UK	16.9	23.0	29.9	46.9	**18.3**
		to other EU countries	7.3	10.0	12.6	21.0	**7.9**
		to the rest of the world	6.4	8.6	9.4	16.4	**6.9**
Sold over EDI	2008		4.2	14.1	24.9	28.0	**6.4**
	2009		4.3	14.0	26.9	32.9	**6.5**
	2010		5.3	12.1	23.8	31.4	**7.0**
	2011		5.5	14.4	27.5	33.8	**7.5**
	2012		4.3	11.4	23.8	33.7	**6.0**
		to the UK	4.3	10.8	23.0	32.5	**5.8**
		to other EU countries	0.9	3.8	9.6	14.1	**1.6**
		to the rest of the world	0.7	1.6	5.6	10.2	**1.0**
							Source:ONS

Table 2.10 – Proportion of businesses making e-commerce sales, by size of business, 2008 to 2012, ONS

As shown in Table 2.10, the proportion of businesses making e-commerce sales over websites has been growing year-on-year in almost all business size bands since 2008. However, the proportion of larger businesses making sales over websites is far greater than in smaller businesses. Interestingly, the proportion of businesses selling abroad, out of those selling over websites, is similar across all size bands.

2.3 Urban-Rural Divide

The rural economy in most countries is regarded as that which requires intervention in order to foster sustainability and development. With improved trust and use as a transaction medium, increasingly ‘‘the internet is uniquely poised to promote and deliver services, both to individual and business customers’’ (Zinkhan, 2002, p. 423).

The Rural Business Survey (Wales Rural Observatory, 2010) reports that the perceived advantages of a rural location to businesses were attributed to four interconnected factors. Firstly, many survey participants commented on the natural beauty of much of rural Wales and how this enhanced their working conditions. Some respondents saw an advantage in that the rural landscape and environment attracted visitors and afforded economic opportunities. Another contributing factor was lifestyle, with a number of lifestyle elements cited, including peace and quiet, a more relaxed way of life, better travelling and commuting conditions, and closer communities. Closer communities embraced economic factors such as knowing and trusting both customers and suppliers, and the use of family and community networks to employ workers and to build a business reputation. Furthermore, economic competition was seen to be less keen than in more urban areas. Finally, it was observed that overheads such as rents and insurance tended to be lower in rural areas. A number of participants argued that with the advent of the Internet and broadband they could conduct their business from practically any location (Wales Rural Observatory, 2010 p18).

Participants in the survey also perceived a number of disadvantages for businesses located in rural Wales. Some were the obverse of what those in the previous sub-section saw as advantages. The costs of geographical isolation, albeit in beautiful locations, including long distances to be travelled, the necessity of personal vehicular transport, poor roads, inaccessibility, particularly in bad weather, limited services, a shortage of quality goods available locally, and high fuel costs were all perceived to be disadvantageous. Similarly, while some perceived close communities and local networks as an advantage, others disagreed, observing that potential downsides to close local networks were

rumour-mongering, social and business isolation, and unfair competition. In terms of the local economy, it was argued that in rural areas there was a tendency for a low-income, low-skills economy, with perceived shortages of skilled or appropriate local people available for employment. Taken together with small local populations and little passing trade, with much of that seasonal, the result could be a small customer base, low business turnover and small profits. In addition, it was argued that rural business rates were too high. It was further argued that a rural location could be perceived negatively by potential urban customers and suppliers as an indicator of a lack of business competence and expertise. Finally, some participants argued that with good broadband businesses location was irrelevant for some indicating that broadband can be seen by some businesses as a leveller between rural and urban areas. However, other business owners observed that in their location broadband was either non-existent or inadequate, and that telecommunications, both fixed-line and mobile, were unreliable (Wales Rural Observatory, 2010 p19).

2.4 Conclusions

This chapter has shown that SMEs are a vital part of the economy in the UK, and in Wales particularly where SMEs represent 99.9% of all enterprises in the country, accounting for more than three-quarters of all employment (76.5%) and three-fifths (62.2%) of turnover.

Internet and broadband adoption and use have increased substantially in businesses over recent years. However, as this chapter has shown, adoption and usage increase as business size increases.

This chapter has also highlighted the fact that smaller businesses are far less likely to have high speed broadband services than larger businesses which raises the question; are smaller businesses failing to fully utilise the potential of broadband due to having lower quality broadband services?

Chapter 3 - Broadband Policy and influencing factors.

3.1 Introduction

This chapter provides an insight into the development of broadband policy and funding necessary to establish the infrastructure to enable broadband accessibility to all users, particularly in the rural non-commercially viable areas. In many countries decisions on broadband infrastructure delivery has developed over a period of about ten years as problems of ubiquitous rollout to all areas is not dependent solely on commercial profitability. Urban areas which are sufficiently populated with potential broadband service customers to allow telecommunication network providers to generate a profit on their investment are obviously at a huge advantage, both economically and socially, over their rurally located neighbours. These disadvantaged rural areas are therefore dependent upon government funding to bridge the gap between their inefficient broadband services and the better quality services enjoyed elsewhere. Decisions by governments to allocate such funding are influenced by present national and international economic factors together with the problem of deciding when to initiate projects based upon the best technology available at that time. This is particularly so in the case of the UK and Wales, where early initiatives were focused on attaining broadband speeds of up to 2Mbps to particular geographic areas, whilst now, in 2013, the objective is to provide superfast broadband services of at least 24Mbps and above to all areas.

Examples are also provided on how regional and national impacts of broadband are recognised, particularly in terms of economic impact and jobs creation. These factors are important in helping governments decide on the amount of public funding to allocate to such developments.

3.1.1 EU

The creation of a knowledge and innovation based society is one of the major priorities of the EU and the role of advanced ICT, driven by broadband technology take-up, in rural areas was recognised as a key driver for rural development within the Lisbon agenda (EU, 2012).

The Lisbon Agenda was adopted by the European Council in 2000, with the aim of turning the EU into the most competitive and dynamic knowledge-based economy, capable of sustainable economic growth with more and better jobs and greater social cohesion by 2010. Within Wales and the rest of the UK, important national and regional strategies regarding employment, higher skill

provision and wider and better use of modern technologies have been influenced by the Lisbon Agenda. The strategy was produced to be a driving force for European competitiveness, and to influence progress towards a more attractive and competitive Europe. The mid-term review of the Lisbon Agenda carried out in 2005, recognised that SMEs, which are key components of the rural economy, are making a crucial contribution to the achievement of these goals (EU, 2005).

As well as the economic benefits that can be gained through broadband, the Lisbon Agenda also considers the social and educational benefits that can be achieved. Some of the priorities of the Lisbon strategy include the provision of public services online, with an electronic administration and services of electronic learning and eHealth. All the schools of the Union will have to be connected to internet and all the teachers able to use it.

Information Society policies address core objectives of the Lisbon Growth and Job Strategy. They;

- drive productivity growth,
- create an open and competitive digital economy,
- stimulate innovation to tackle changes of globalisation and demographic change.

Production and use of ICT are key to modernising our economies. Expanding broadband coverage across the EU is seen as key to maintaining the bloc's innovative base and competitiveness. The EU executive demonstrated this by pledging to reallocate €1 billion of unspent EU money to bring broadband to rural areas.

According to the EU, the number of fixed broadband lines more than doubled between July 2005 and July 2008, 30% of the EU's rural population still has no access to the Internet, noting that the situation differs widely from one country to another. By the end of 2009 this latter figure had increased to 80% (with the UK at 100%) but this only relates to the Digital Subscriber Line (DSL) coverage according to the number of exchanges that can theoretically provide the coverage, with no reference to actual take-up of services, data speeds or quality of service. (Commission E. , 2011).

By 2011 approximately 68% of premises across the EU had access to the Internet via broadband services with average annual growth between 2006 and 2011 of 17.88% for Internet access by broadband. (EUROSTAT, 2011).

3.1.2 UK

Within the UK, government broadband infrastructure policy has developed over a number of years with early recommendations being changed and influenced by the challenge of providing ubiquitous coverage across the UK at affordable costs and the availability of improved telecommunication technology. Early policy developments in broadband infrastructure include the UK Government's Digital Inclusion Action Plan, launched in October 2008 (UK Government, 2008), which states that: "Digital technologies pervade every aspect of modern society. However these opportunities are not enjoyed by the whole of the UK population – for example, 17 million people in the UK still do not use computers and the Internet and there is a strong correlation between digital exclusion and social exclusion. The relationship between digital exclusion and social and economic outcomes is deeply entrenched."

The plan gave many examples as to why digital inclusion is important:

- Research shows that there is a 3-10 per cent wage premium for jobs involving computer/Internet use, many jobs are now advertised solely online and recruitment processes are increasingly electronic.
- The Internet, and particularly social networking sites, enables access to support and advice on many different issues which affect families, such as, coping with a young baby or getting support on bereavement.
- Easier access to public services through online services such as paying tax online or applying for schools online can help people manage busy lives – this can be particularly important for example, for people juggling work and caring responsibilities, and single parents.
- It can benefit people to be able to transact and engage with public services online outside working hours.
- Many assistive technologies can help to ensure older people and people with disabilities can participate equally in society, engage directly with others and receive equal levels of service delivery.

The growth of online services also provides ready access to goods and services that may be unavailable or difficult to reach for older people, particularly those living in rural communities – having groceries delivered to the door for example, or accessing a bank account online where local high street amenities are unavailable. Technology has an important role to play in supporting strong

rural communities, in tackling isolation, delivering improved services to remote areas and increasing opportunities for small and medium enterprises.

On June 16th 2009 the Government published Digital Britain Report (Department for Culture, 2009) outlining its strategic vision for ensuring that the UK is at the leading edge of the global digital economy. Of interest to broadband availability in Wales are measures to provide a three year plan to improve digital participation; universal access to today's broadband services by 2012; a Next Generation Fund for investment in tomorrow's broadband services; and mobile spectrum liberalisation to enhance 3G coverage with a fourth generation (4G) higher speed network, and accelerate Next Generation mobile services.

This Government Report confirms that rural Wales is suffering the effects of bad telephone lines due to line length and poor quality. The report also emphasises that the business case for investment in many parts of the UK is challenging, particularly the costs of deploying fibre in the more rural areas. The policy contained in the Digital Britain Report provides guidelines for broadband implementation across the UK, but in Wales the Directorate for Economy, Science and Transport are responsible for delivering the broadband infrastructure in order to support the economy and digital inclusion objectives. The broadband policy initiatives of the Welsh Government are considered in more detail in section 3.1.3.

The UK Government believes that two objectives should be followed. Firstly, the existing network should be made available to everyone by delivering the Universal Service Commitment (USC) at 2Mbps by no later than 2012, and secondly, the network of tomorrow should reach a large proportion of the UK population by various actions.

Although the total cost of achieving this is not fully explained in the Report, the contribution to the USC is expected to come from the following sources:

a) Under spend from the Television Digital Switchover Scheme and a contribution from the Strategic Investment Fund, totalling £200M for the whole of the UK;
b) Competitive commercial pricing through tender contract and design;
c) Contribution in kind from private partners;
d) Universal coverage of mobile broadband;
e) Contribution from other public sector organisations in the Nations and Regions.

Given the present economic climate and the lower numbers of potential customers in rural Wales, the contributions from b), and c) is considered unrealistic, whilst the shared contribution from a) is unlikely to provide sufficient funding. Extending mobile coverage in Wales, d), is a bigger challenge than in other UK areas and mobile broadband speeds are unlikely to exceed between 1 and 1.5Mbps during the period leading up to 2012 due to the dependence on 2G coverage in some areas. The contribution from the public purse, e), is therefore possibly the more realistic source of funding, but the expected squeeze on public funding is going to create a major challenge to the Assembly and Local Authorities.

The realisation of a ubiquitous 2 Mbps service across many rural areas of the UK, particularly Wales, will require technological solutions in addition to copper wire, due to the limitation of line lengths. These solutions may well include various wireless solutions or early local rollout of fibre based services. The latter would deliver the best solution as this will provide a higher speed NGA service. Nevertheless, delivering the USC in Wales, at costs that have not been fully defined in the Report, will be difficult to achieve.

The report also suggests initiatives to extend NGA services to at least 90% of homes and businesses in the UK by 2017. The arguments for expansion of NGA networks are given as:

- International competitiveness – NGA is recognised as essential by many countries. Even first generation broadband, over a period 1998-2002, employment in communities with broadband grew 1 percentage point more than those without, and a study for the EU estimates that broadband contributed an average of some 0.71% to EU GDP in 2006. Further gains from NGA are difficult to predict but must nevertheless be significant.
- Economic situation – the worsening economic situation over the past 3-4 years. NGA rollout is seen as playing a potential role in creating a short term stimulus as well as strategic infrastructure.

On the subject of NGA rollout the Report recognises that market-led investment, by virtue of the UK's competitive markets, will provide the stimulus for further investment without any Government intervention for between half and two-thirds of the population. Extending coverage to the remaining population will require targeted intervention. This is further supported by the statement "the economics of next generation broadband deployment mean that there will remain up to a third of

the country – both homes and SME's – not served in the way that the rest of the country is by the fixed telecoms market".

The role of mobile broadband is mentioned as a possible means of connectivity across the country – LTE (Long term Evolution), a 4G mobile technology, is capable of delivering speeds up to 50Mbps, in a competitive, multi-operator market. Steps will be taken to ensure spectrum is available for use and the market remains competitive. Nevertheless, the Report also mentions that the cost of deployment will rise in the final third of the country, meaning the investment required to install the density of mobile base stations needed to support very high bandwidths become uneconomic.

The Report refers to the increasingly widespread conclusion from industry and economic analysis that there is no obvious means whereby the market, unaided, will serve the final third of the population. In order to provide a possible solution, the Report proposes a Final Third Project to deliver at least 90% coverage by 2017 and, it is hoped; accelerate the expansion of the boundary of market provision from 50% to the two-thirds coverage level.

The Final Third Project will include a Next Generation Fund (NGF) in order to generate the substantial funds needed to support such an undertaking. The Government intends to propose a small general supplement on all fixed copper lines (residential copper lines, the equivalent business telephone and ISDN2 lines and cable telephony lines) from 2010 for the Fund. The NGF supplement will be 50p per month per customer which is expected to rise £150M - £175M a year for the Fund. This, according to the Report, might be sufficient to make investment in connecting most of the Final Third by 2017 as commercially viable as connecting the first two thirds of the population.
Other proposals within the Final Third Project include:

- £15,000 grants to support the Independent Networks Co-operative Association with work on standardisation and inter-operability between local networks. This will enhance localised and community network development.

- Encouragement of utilities to share street-works to limit the large civil costs. The Government will also work with utilities and public authorities to facilitate better use of existing mechanisms. By 2012 their goal is the provision of information relating to all street works planned for 1-2 years ahead for those likely to work in the highway. Government

would like to move to a system in which all utilities offer to share works with other interested parties, with option of enforcing a 'must offer' system, if necessary.

During May 2011 the Department for Culture, Media and Sport (DCMS) published the Broadband Delivery Programme with an updated version in September 2011 (DCMS, 2011). This document set out the plan to stimulate investment in the UK's broadband infrastructure and covered the delivery of the UK Government's investment and policy approach to bringing forward network infrastructure upgrades to improve access to services in locations where there is a weak commercial investment case. Broadband Delivery UK (BDUK) was created by DCMS to deliver the government's policies relating to stimulating private sector investments using the available funding. This therefore updated the original plans set out in the Digital Britain Report and the Next Generation Fund with revised target dates and a new pricing profile. The five primary goals of BDUK are:

i] support economic growth in the UK, including rural areas;

ii] ensure that the UK has the best Superfast Broadband[2] in Europe by the end of the current parliament (2015);

iii] deliver a Standard Broadband[3] to virtually all communities in the UK within the lifetime of the current parliament (2015);

iv] ensure the efficient use of funding to deliver Superfast Broadband and Standard Broadband; and

v] assist other Government initiatives which are dependent upon customer's ability to access broadband based services.

The BDUK funding profile over the period of this programme (2010-2015) is £230.5M from the Digital Switchover Scheme[4] and £300M from TV licence fees, giving a total of £530.5M. Additionally, the TV licence settlement cover the period up until 2017, therefore a further £150M will be available in each year of 2015/16 and 2016/17 will be available for BDUK funding, if required.

[2] Superfast Broadband - BDUK defines this as "infrastructure capable of delivering speeds higher than 24Mbps, in line with OFCOM definition. BDUK also defines this as headline download speeds of greater than 24Mbps". It should nevertheless be noted that the International Telecommunications Union [ITU] defines the data speed of superfast broadband as being 30Mbps or above

[3] Standard Broadband – BDUK defines this as "a service available at the edge of the network that allows a quality home working experience, for which a headline access speed of 2 Mbps can be used as a proxy"

[4] Digital switchover was the process of converting the terrestrial television system to digital in the UK. Analogue TV channels were switched off region by region and replaced with free-to-air digital TV and radio services (Freeview). As well as extending Freeview coverage to virtually the whole of the UK, Digital Switchover freed up airwaves for new services such as wireless broadband and mobile television

European Regional Development Fund (ERDF) may also be available for local broadband projects from the EU to match other funding. This is primarily to improve the infrastructure so that businesses can improve their competitiveness through improved broadband access.

The programme has been subject to delays as there have been concerns that the rural broadband rollout programme has been put on hold by the EU regulators. An issue has arisen whereby only two companies (BT and Fujitstu) have been selected to receive funding from BDUK and that one of these companies is unprepared to offer access on a sufficiently open basis to the infrastructure it will roll out. (ITU, ICT Statistics Newslog - Rural Connectivity, 2012)
Although both companies have signed contracts on the 13th July 2012 the official green light from the EU was finally granted on the 21st November 2012 (Europe, 2012).

3.1.3 Wales

Some policy intervention has already been undertaken within Wales to enable citizens and businesses with access to a broadband connection. The Broadband Wales Programme was implemented in July 2002 to underpin the delivery of improved and more accessible public services and underpin a positive economic outlook for Wales through addressing 'market failure' - as identified in the 'Ubiquitous Broadband Infrastructure for Wales' report commissioned by the Welsh Development Agency in 2001 (WDA, 2001). Market failure often exists in rural areas due to low population density of potential customers. These areas are less commercially attractive to private investment or even entirely economically unviable for investment altogether. Due to the continued lack of competition in the telecommunications sector in many areas of rural Wales, and little evidence to suggest that this is likely to change, further Government intervention, possibly with private partnership, is necessary to improve broadband service levels.

A series of interventions aimed at addressing market failure and increasing the roll-out of broadband was developed and the programmes [described below] included projects focused upon both supply and demand:

Demand stimulation/marketing - A three year all Wales campaign targeted at business, consumers and opinion formers. Its over-riding aim was to achieve a 'step change' in Wales with regards to the perceptions and attitudes towards broadband and subsequently to increase the uptake of broadband and encourage more effective use of the technology in the home and in businesses. The

campaign included: direct marketing, advertising in the local and national press as well as on the radio, and market research including surveys to better understand the characteristics of the Welsh marketplace and the specific needs and attitudes of citizens and communities towards broadband.

The SME Satellite Broadband Subsidy Scheme **-** initially focused on giving SMEs a subsidy of up to £1,500 to take up broadband via satellite subject to a certain set of conditions, the scheme became technology neutral in February 2004 and was extended to also include the voluntary and charity sectors.

Try Before You Buy – A network of 24 ICT Support Centres across Wales were enabled with broadband services to offer broadband 'try before you buy' facilities to businesses.

Regional Innovative Broadband Support (RIBS) **-** The RIBS project was specifically to provide access to 'first-generation' broadband services throughout Wales, at a cost that is comparable with urban areas of Wales. The Objective 1, European-funded project provided broadband access to the 35 exchanges in Wales that were not originally enabled by BT due to being considered economically unviable for upgrading. Furthermore, a series of projects to address the issue of not-spots across Wales have also been undertaken. A broadband brokerage website was created allowing companies, public sector organisations and individuals to register their interest in using broadband in order to locate the not-spots in Wales.

During December 2008, The Deputy First Minister and Minister for the Economy and Transport Ieuan Wyn Jones announced that six 'not spot' areas in Wales were to be provided with broadband services. Lines serving the West Wales communities of Reynalton, Saundersfoot, Llanpumsaint and Bronwydd Arms, Cilcennin in Ceredigion and Gwytherin in North Wales are expected to be "ready for service" in all six areas by the end of September 2009, allowing more than 1,000 residents and businesses to access broadband services for the first time. These areas all now have access to broadband.

On announcing this latest stage of the project Mr Wyn Jones said – *"It is vitally important that businesses and families have good access to broadband in all parts of Wales. The Regional Innovative Broadband Support project is tasked with this but for technical and commercial limitations it has been difficult to achieve this in parts of the nation. We are working hard to assess the exact*

scale of the problem and how best to solve it and today's announcement demonstrates a commitment to getting the job done."

BT is continuing to work through the RIBS contract to address some of the known not spots – while the Assembly Government are currently working on a detailed analysis of the potential total number.

Public Sector Broadband Aggregation Project – This project aimed to establish the most effective way of procuring broadband connectivity to the public sector throughout Wales, giving consideration to strategic, operational and economic benefits, with a particular focus on interoperability and collaborative working. A number of working groups consisting of local government, health, the higher and further education sectors and others, assisted in the development of the business case and identifying the most appropriate solution regarding broadband aggregation.

Lifelong Learning Network **-** The Lifelong Learning Network is a Wales wide high-bandwidth network designed to address the aggregated broadband connectivity requirements of public sector organisations. The project is designed to deliver broadband connectivity to schools, libraries and learning centres throughout Wales. Its purpose was to achieve best 'value for money' through a rational and focused investment in infrastructure, improving the availability of broadband for Wales; drive economic development; increase competitiveness and address the digital divide. Local Authorities can also use the Lifelong Learning Network to support their own electronic traffic.

FibreSpeed - This £30 million initiative provides a fibre optic network for North Wales, linking 14 strategic business parks throughout the region with high-speed broadband services. It is also intended to encourage development of a comprehensive network to serve a growing number of communities. The project has been funded by the Welsh Assembly Government with support from the European Regional Development Fund, which are managed by the Assembly Government's Welsh European Funding Office (WEFO).

Forming part of a long term Welsh Assembly Government programme to transform high bandwidth availability and pricing across Wales, it is the first government supported network of its kind in the UK. The first phase of the project included the installation of over 200 miles of brand new fibre optic infrastructure and broadband 'points of presence' built in the 14 business parks by Geo, the supplier

chosen to build and operate the network. Service Providers are invited to develop commercial relationships with FibreSpeed to offer competitive broadband retail propositions over the network.

Announcing the completion of the first stage of the project, Mr Ieuan Wyn Jones, Minister for the Economy and Transport, said - "This exciting advance helps arm Welsh businesses with a powerful competitive advantage in resisting the global financial crisis and preparing for the economic upturn that will follow." Project Chief Executive Chris Smedley added - "Access to high speed communications has been highlighted as a critical part of success in the modern world, spanning every aspect of life from children's performance at school to businesses' ability to compete in the global economy. Its world class infrastructure will create a new local telecoms market while giving businesses the opportunity to innovate, grow or relocate to the region."

Whilst work has already been done to bring Wales into the 'Digital Age', more work is required before Wales can benefit fully from the benefits that are achievable through advanced ICT and broadband technology and that rural areas in particular are in danger of becoming victims of the 'digital divide'.

The Welsh Government's 'Superfast Cymru' next-generation broadband project plans to introduce a next-generation fibre based service to 96% of the country by 2016. Superfast Cymru is being funded with a mixture of Welsh Government funding, UK Government funding, EU funding and private investment, amounting to a total investment of £425 million (Research Service, 2013). The breakdown of public funding is as follows:

- £58.6 million of Welsh Government funding:
    - £30 million of Centrally Retained Capital; and
    - £28.6 million of Economy, Science and Transport capital budget.
- £56.9 million of UK Government funding;
- £89.5 million of European funding:
    - European Regional Development Fund Convergence of £80 million; and
    - Competitiveness funding of £9.5 million;

The recent green light from the EU (21st November 2012) to allow the ERDF grant to be used alongside the BDUK funds will now trigger the necessary work required to accelerate the ubiquitous coverage of broadband infrastructure across Wales, and the rest of the UK.

3.2 Examples of International and Regional Economic Impact of Broadband.

The following section presents examples of how broadband features in the importance to administrations in terms of regional and national benefits. Broadband technology is a contributor to economic growth at several levels. Firstly, the deployment of broadband technology across business enterprises improves productivity by improving business processes (e.g. marketing, inventory optimisation, and streamlining of supply chains). Secondly, extensive deployment of broadband accelerates innovation by introducing new consumer applications and services. Thirdly, the construction of the broadband infrastructure in itself generates jobs and economic growth.

3.2.1 United States

An early attempt by the US Department of Commerce to measure the economic impact of broadband reported that "broadband access does enhance economic growth and performance, and that assumed economic impacts of broadband are real and measurable". As early as 1999, in communities where mass-market broadband became available, experienced more rapid growth in employment and number of new businesses (US Depatment of Commerce, 2006).

Research into the jobs that could be generated as a result of the grants to be disbursed by the broadband provisions of the American Recovery and Reinvestment Act, published February 13, 2009 showed that approximately 128,000 jobs could be created over a four year period (i.e. 32,000 per annum from network construction with each job costing $50,000). It is interesting to note from this report that a similar investment in "roads and bridges" transport infrastructure construction would yield 152,000 jobs at a cost of $42,000 per job. Nevertheless, the transport infrastructure would generate these jobs over the project build period, but with broadband many more external jobs could be created over a much longer period. The report suggests that this figure could be as much as 67,000 jobs per annum. (Katz, 2009).

3.2.2 International

Further reports providing indications of broadband's impact on economic benefits and on jobs are shown in Tables 3.1 and 3.2. This information is contained within a report commissioned by the Broadband Commission for Digital Development which was launched in May 2010 by the ITU and the UN Educational, Scientific and Cultural Organization (UNESCO) in order to make progress in

achieving the Millennium Development Goals (Appendix A) by 2015, as set by the UN. The Commission reports that "it is essential that countries and communities everywhere are enabled to take advantage of the broadband revolution – if they are not, they will lose the opportunity to reap the economic and social benefits that broadband brings".

Country	Economic growth
Germany	An investment of EUR36 billion will return EUR22.3 billion to the economy during network construction, as well as externalities of EUR137.5 billion.
Japan	If the Japanese economy grows and the potential of ubiquitous networks is fully utilized, the real GDP growth rate will be about 1.0 to 1.1 points higher than otherwise.
China	The development of China's dial-up and broadband Internet together may contribute a combined 2.5% of GDP growth for each 10% rise in penetration.
UK	By 2015, the productivity benefits of broadband could result in the GDP of the UK rising by up to £21.9 billion.
15 OECD nations, 14 Europeans	One more broadband line per 100 people in these "medium to high ICT" countries raises productivity by 0.1%
Global	Broadband is a key driver of economic growth, providing a boost of 1.38% in GDP growth in developing countries, for every 10% rise in penetration.
	Source: ITU/UNESCO 2011

Table 3.1 – Broadband impact on GDP: Country examples

Country	Jobs creation
Germany	Broadband network construction will create 304,000 jobs between 2010 and 2014, and 237,000 between 2015 and 2020. Also, it is estimated an additional 427,000 jobs will be created: 103,000 in 2010-2014 and 324,000 in 2015-2020. The accumulation total jobs over a ten- (M Fornefield, 2008)year period [2010=2020] will reach 968,000.
UK	An additional £5 billion investment in broadband networks would create or retain an estimated 280,500 UK jobs for a year.

USA	Broadband added 10-14% to the growth rate in the number of jobs between 1998 and 2002. For every 1% increase in fixed broadband penetration in a single US state, employment is projected to increase by 0.2 to 0.3% per annum.
	Source: ITU/UNESCO 2011

Table 3.2 – Broadband impact on job creation: Country examples.

3.2.3 United Kingdom

A study on behalf of the EU described economic impacts of broadband on Cornwall, UK (Fornefield, 2008). It was reported that the image of Cornwall had changed from a rural laggard to a region where it is worth living and working. It has become more attractive to investors, for innovative businesses and for young people who are now returning to the region. Since 2002, about 4300 broadband related jobs have been created and according to Local Intelligence Network Cornwall (LINC) (LINC, 2007) "the investment in broadband technology has been a significant boost to Cornwall and the Isle of Scilly, given its peripheral location".

A study commissioned by the BT Group into the economic contribution of BT to the national and regional economies considered the effect on jobs, output (turnover/sales revenue that is generated directly within BT or within other businesses in the economy through indirect and induced effects) and Gross Value Added (GVA) resulting from BT's investment in fibre-based on superfast broadband (Regeneris Consultancy, 2012). The report quotes that "for any one location such as rural area, town or city it is expected that superfast broadband could create between £143M and £19.8B in additional GVA. This equates to an annual increase in GVA of between 0.3% and 0.5%". These figures are derived from business impacts which result from superfast broadband arising from a combination of improved business performance, business creation as a result of Cloud Computing and enhanced home working opportunities. Table 3.3 provides predictions of economic impacts across the UK, based on the results of this study.

	Rural Areas	Town	City	Capital City
Annual increase In GVA	0.3% per annum over 15 years	0.5% per annum over 15 years	0.4% per annum over 15 years	0.5% per annum over 15 years
Business Start-ups as a result of	1,470 plus support for 7,780	140 plus support for 1,030 home	320 plus support for 1,580 home	6,600 plus support for

Cloud Computing	home workers	workers	workers	73,000 home workers
Job creation	1,810 jobs	225 jobs	436 jobs	26,200 jobs
				Source: BT Group

Table 3.3 – Predictions of economic impacts across the UK

3.2.4 Wales.

A study by Atkins concluded that the benefit of broadband to the Welsh economy over the period 2000 to 2015 to be £1,388 million [Atkins, 2000]. At a regional level within Wales the South East Wales Economic Forum (SEWEF) capsulated the perceived benefits of broadband to their region as strengths in a SWOT analyses (Written evidence submitted by South East Wales Economic Forum to the Welsh Affairs Commitee: Evidence Ev 65, 2011)as seen below:

Strengths :

- E-Crimes Prevention and e-Security provision enhanced
- Digital classrooms to improve teaching and training
- Capacity to expand data warehousing provision and creative industries [this being a Welsh government priority sector]
- Capacity to create stronger base for ICT companies.

Weaknesses:

- Region has lower broadband take up than other parts of rural Wales
- Topographical issues re: Valleys
- Advertised verses actual broadband speeds
- Poor broadband speeds hindering attempts to grow Welsh businesses internationally.

Opportunities:

- By 2016 higher speed broadband than the rest of the UK, if Welsh government meets its target
- Supply chain developments
- Increased home-working/decreased travel congestion.

The report also comments that “forward looking local authorities are actively working on promoting and enabling fast broadband infrastructure to provide connectivity for SMEs, home-working and developing niche digital markets”.

3.3 Conclusion

Broadband is having a significant impact on the economy today and the various impacts highlighted above are set to continue into the future. It has not yet been proven that next generation broadband will have an equal impact but there is a strong possibility that it could and Wales needs to be in a position to take advantage of this possibility. It seems highly prudent, therefore, for government to pay close attention to the evolution of the market and the prospects for next generation broadband deployment and be prepared to take proactive steps.

In a situation where there is a probability, but not a certainty, that: a) next generation access may deliver significant economic benefits; b) demand for bandwidth may exceed the capabilities of current technologies; c) investment incentives for next generation broadband may remain weak; the policy instinct will be to leave the market to determine the outcome. However, this also carries a risk. If significant efficiency gains are derived from next generation broadband, then it is possible that nations that opt for accelerated deployment will gain competitive advantage over those that do not.

The examples of developments in different countries provided in this chapter indicate that many countries are recognising the potential benefits of faster broadband, particularly via fibre networks. The justification to invest large budgets, particularly in rural areas are initially difficult, but different business models are deployed to share investment costs by the private sector and government agencies, with the latter usually providing a significant portion.

Given the critical importance of broadband as the key enabling infrastructure of the knowledge economy, a failure of broadband supply to meet demand could stifle the pace of innovation in the Welsh economy compared to our global competitors. This risk is being recognised by the UK and Welsh governments with budgets being allocated to create this infrastructure. Only time will tell if these plans are fulfilled.

To a large extent, the potential risk/benefit to the Welsh economy depends upon how investments in next generation broadband are made and utilised in other countries and the extent to which economic benefits start to emerge from these networks. Government should, therefore, begin to regularly monitor the deployment, use and exploitation of next generation broadband in key leading economies. The evolution of Wales' own communications infrastructure can then be benchmarked against our global competitors.

Many countries around the world have set inspirational targets for next generation broadband deployment, including targets for FTTH adoption. Targets are valuable because they help to focus policy development and signal policy intent to stakeholders.

In cooperation with stakeholders, the government should establish a target to ensure that Wales remains competitive in terms of the range of broadband delivered services to which its people have ready access (Quality) and the proportion of the population served by broadband (Reach). 'Quality' and 'Reach' should be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets set in 2001.

Chapter 4 – The Telecommunications Landscape in Wales

4.1 Introduction

Having considered the importance of broadband to national and regional areas and initiatives to create a common quality broadband infrastructure across rural and urban areas in Chapter 2, this chapter provides a more detailed assessment of the telecommunications landscape in Wales which will form the subject of a comparative investigation of broadband utilisation between rural and urban SMEs.

This thesis concentrates mainly upon the impact of broadband on SMEs and it is therefore important to understand the availability of broadband services to SMEs, as this directly affects the level of impact. This chapter therefore describes the current telecommunications landscape in Wales, including the availability of telecommunications services, featuring fixed-line, broadband and mobile. It also provides an insight into the evolving developments in the creation of the telecommunication infrastructure with rollout targets for future availability of broadband services.

4.2 Telecommunications Infrastructure Availability

4.2.1 The Core Network Infrastructure in Wales

A core network is a backbone network that provides connections among devices on the network carrying the aggregated traffic from all services from city to city, and within cities, to the edge of the network, where individual access connections then carry customer-specific traffic to the customer residence or premises. The Internet could be considered to be a giant core network, however, in reality, it consists of many service providers running their own core networks, which are interconnected. Due to having to carry very large amounts of data, backbone networks are generally made of high-capacity fibre optic lines.

As shown in Figure 4.1, below, the fibre backbone infrastructure in Wales is plentiful. This map shows some of BT's main fibre routes in Wales but there are also other fibre networks owned by other network operators.

Figure 4.1 – The Fibre Backbone Infrastructure in Wales, BT

However, the problem within Wales is access to fibre at economic levels that are fair to the users and the owners. The cost of backhaul access, i.e. the transmission links between cell sites and the system operator's switching centre, has been identified as a major problem in Wales. A significant barrier is that existing pricing structures are distance related i.e. the further premises are from the main termination point in London (in network routing terms rather than a purely geographical basis), the more expensive backhaul services will be. This is both an economic and regulatory issue. Intervention to secure non-geographic averaging of pricing for some backhaul products might be justified as there appears to be little competitive activity in this area in Wales.

The rental costs of retail leased lines (dedicated internet access products) in many areas in Wales are also very high. This is also due to costs being based on distance related tariffs and the fact that these leased lines terminate in London. Consequently, in spite of price regulation imposed on BT for certain products, the price for these products can be considered as unaffordable for many SMEs. A new service that would enable leased lines in Wales to terminate at a Point-of-Presence (POP) based in Wales e.g. the BT Datacenter in Cardiff (or another node on BT's core network in Wales), could be considered as a way of rectifying this issue.

A pricing comparison study undertaken in 2006, comparing the pricing of high-speed services in Wales to prices in other, competitive urban areas in the UK, showed that the cost in Wales was 2.7 (for a 10 Mbps Internet connection) to 7.2 (for a 100 Mbps Internet connection) times higher than in London, (EU, 2006). Furthermore, BT does not make its own ducts or "dark fibre"[5] available to third parties and there is only very limited fibre from alternative operators or energy providers available in Wales. As such, this limits the opportunity for service providers to access passive infrastructure over which it could provide its own products and services at both a wholesale and retail level. Due to topography and economics, there is little prospect of market players making any investment in Wales to create an alternative wholesale infrastructure. Consequently, this seriously affects the ability of small and medium-sized enterprises to compete in the global knowledge economy with businesses from other regions of the UK, as well as Europe and beyond, which have the benefit of available high-speed broadband infrastructure at competitive prices.

The situation regarding backhaul has improved in some parts of Wales due to FibreSpeed, a key initiative within the Welsh Assembly Government's Broadband Wales Strategy 2005-2007 (Welsh Assembly Government, 2005). As described in section 2.1.3 of this thesis, this project was aimed at addressing the objective of providing affordable 'fibre speed' broadband connectivity (a minimum of 10Mbps symmetric with multi-Gbps capability and greater as technology develops in the future) to business parks/locations in Wales. The project is also aimed at meeting the objective of ensuring that Wales has extensive access to competitive wholesale infrastructure.

The FibreSpeed network is an 'open access' network that will comprise both local access networks at the target locations, a backbone network interconnecting these locations to other telecoms networks and points of presence distributed across the network. FibreSpeed will make a range of wholesale products and services available to service providers on an open and equal basis.

While FibreSpeed will not directly determine retail pricing, wholesale prices will be set to enable key pricing objectives to be met. Prices will be benchmarked against the most competitive parts of the UK, namely London and the South East of England, and that for most products wholesale pricing will not vary by target location.

[5] Dark fibre – Unused optical fibre. Often used to refer to potential network capacity or the practice of leasing optical fibre cables from a service provider.

The selected operator of the network will be required to build/buy and operate a backbone network linking the business parks with a series of local access networks on the targeted business parks. The project covers both the passive and the active network architecture, i.e. the underlying physical infrastructure and the electronic/optical networking equipment needed to provide wholesale services over the network. The wholesale operator will have to offer dark fibre and wholesale high bandwidth services to operators of electronic communications services who will serve the business end users. The wholesale operator will itself not offer services to end users. Access to the network and the provided wholesale services will be on an open, carrier-neutral, non-discriminatory basis and all service providers will be treated equally, i.e. the terms, conditions and contractual arrangements will be the same for all operators using the wholesale operator's services. The network infrastructure will remain in public ownership and has to be returned to the authorities by the wholesale operator after the end of the project.

The project will initially deliver connectivity to 14 business parks in North Wales; with subsequent phases being developed to cover other parts of Wales, with an estimated 50 strategic sites in total throughout Wales.

Whilst businesses on strategic sites form the initial target sector, the Welsh Assembly Government expects that FibreSpeed will, in the future, have the potential to support the requirements of citizens, communities and the public sector (EC, 2006).

The current status of the FibreSpeed project is that 12 business parks have been connected between Manchester, Caernarvon and Holyhead, providing high quality broadband access to 185 SMEs (Government, 2012). Additionally, the project has extended the network by using wireless technology to cover surrounding rural 'not-spot' areas. This has enabled businesses to access funding from the Welsh Government Broadband Support Scheme to help pay for this service (Government, FibreSpeed Newsletter, 2012).

4.2.2 Fixed-line Availability

The local access network in Wales consists mainly of copper cabling that links each end-user premise to a local telephone exchange. The twisted pair of copper cabling is often referred to as the local loop. The exchanges are, in turn, connected to a backbone network to form the PSTN.

Fixed telephony over PSTN is available to the whole of the Welsh population due to the Universal Service Directive (USD) (European Commission, 2002). This means that BT, the telecommunications incumbent in the UK, is obliged to provide fixed line services throughout Wales at a standard charge. Consequently, this gives 100% fixed-line availability throughout Wales. However, additional connection charges apply in remote areas where installation costs are higher than £3,400. The USD also mandates BT to provide affordable telephone services for members of the community who are less advantaged in the form of special pricing schemes (Ofcom, 2008).

Currently, Wales suffers from low levels of infrastructure competition compared to the rest of the UK and many other nations around the world. At the local access level, most Welsh premises are restricted to using BT infrastructure only. It is only within some urban areas of South Wales, particularly in and around the cities of Cardiff, Newport and Swansea, where access to telecommunications services are available via other telecommunications infrastructure, mainly the Virgin Media cable network which supplies 24% of premises in Wales (Committee, 2012). This is the lowest proportion of households passed by Virgin Media's cable broadband network in the UK, less than half the figure in England, which is 47%. The broadband speeds provided by Virgin Media are to be increased between February 2012 and August 2013 to "up-to" 120Mbps to all households, thereby further increasing the difference between broadband speeds of rural and urban customers, and adding to the differential between Wales and other UK regions. (Ofcom, The Communications Market Report - Wales, 2011).

4.2.3 Broadband Availability

The main technology for supplying broadband in Wales is DSL over a standard copper telephone line connected to a BT exchange. The only other mass-market broadband delivery technology in Wales is via cable-modem to a cable operator's hybrid fibre-coaxial network i.e. Virgin Media. Satellite and wireless broadband services are also available in some parts of the country, although these connections make up less than 1% of all broadband connections in Wales (Ofcom, 2008).

According to BT, more than 99% of premises in Wales are connected to a DSL enabled exchange. However, due to localized technical issues such as distance between the end-user premises and the exchange, or poor quality of networks, some premises within these exchange areas are not suitable for the reception of broadband services, or can only access services at very low bandwidths (BT, 2008).

Due to cable infrastructure only being available in and around the major cities, Wales has been highly reliant upon DSL for broadband delivery and rural Wales even more so. To highlight just how reliant, OFCOM estimate that more than 8 in 10 broadband connections in Wales are supplied via DSL, compared to around 7 in 10 for the UK as a whole. This is largely due to the lower availability of alternative infrastructure, such as cable in Wales (Ofcom, 2007).

The most commonly used variant of DSL technology that is used for broadband delivery in Wales is ADSL (Asymmetric Digital Subscriber Line). ADSL allows downstream data speeds of up to 8Mbps and upstream data rates of up to 800kbps. One characteristic of ADSL broadband is that the bandwidth available to the end-user deteriorates with the length of the local loop i.e. the cable connection between the end-user premises and the local telephone exchange. Consequently, it is not possible to conclude that 99% of premises in Wales can receive broadband at the maximum data rates that ADSL can deliver since only premises situated very near to a telephone exchange are able to receive a broadband service that delivers data rates at or near the high end of the product capability. Within Wales 18 percent of households are further than 5km from a BT exchange. This compares to only 14 percent in the UK as a whole. The fact that Wales is so reliant upon DSL for broadband delivery, along with the higher proportion of premises being beyond 5km from an exchange, makes Wales particularly susceptible to being left behind when higher-bandwidth services are introduced by operators in the near to medium term future (Ofcom, 2008).

Local loop length is also a particular issue for rural areas, as a greater proportion of premises served by a telephone exchange in rural areas will have a longer than average local loop. Within urban areas households tend to be nearer their telephone exchange and hence have a shorter local loop and higher bandwidths. Within the UK, 25% of rural households are located beyond 5km from their local exchange, compared to just 15% of urban households (Ofcom, 2008). However, whilst the issue of decreasing bandwidth is of greater concern to rural areas this is not exclusively so, as the issue is still relevant to many urban areas that are situated far from their local exchange.

Whilst it is unclear exactly how many premises in Wales are unable to receive a broadband service, during a National Assembly for Wales debate on broadband connections, the Welsh Assembly Government Minister for the Economy and Transport, Ieuan Wyn Jones, was quoted as saying that “Through industry data, we know that up to 40,000 areas in Wales could be not spots (areas that cannot access broadband)” (Wales, 2008).

DSL access infrastructure in Wales is owned by BT and any competition on a wholesale level is provided by Local Loop Unbundling (LLU) operators. There are ten LLU operators now actively involved in the market in Wales; AOL, Cable & Wireless, Edge Telecom, Entanet, O2/Be Unlimited, Pipex, Sky/Easynet, TalkTalk, Tiscali and Updata (Knows, 2012). LLU availability has increased rapidly in Wales in recent years with almost two-thirds of all Welsh households connected to an unbundled exchange at the end of 2007 (Ofcom, 2008); double the number in the previous year (Ofcom, 2007). This has further increased by the end of 2011 to 88% of Welsh rural households connected to LLU-enabled BT exchanges with 100% of urban households now connected. (Ofcom, 2012). With regards to coverage in rural areas, LLU operators tend to concentrate on highly populated urban areas for economic reasons and, as such, the geographic coverage of LLU is less than the population/premise coverage.

A Broadband Infrastructure Index (Point Topic, 2010), calculating an index score for all LA areas in the UK. The index focuses on six of the main indicators affecting broadband infrastructure availability:

1. Local loop unbundling (LLU) availability; where do operators such as TalkTalk and Sky/Easynet provide LLU-based services?

2. Twenty-first century network (21CN) roll-out; where is BT's 21CN technology implemented?

3. Cable coverage; where does Virgin Media offer broadband over its cable network?

4. 2Mbps downstream; where can end-users expect to get broadband services of at least 2Mbps download speeds, whether over the BT and LLU DSL networks, or by cable or fibre-based NGA?

5. Current (end-2010) NGA availability; which areas are enabled for some form of NGA service today?

6. Future NGA prospects; what is the average probability that this area will have NGA service by end-2015?

The index reveals a wide range of difference amongst LAs in Wales. Thus, out of the 407 Local Authorities in the UK, Cardiff was placed 71st in the UK and first in Wales, with an index score of 74.9%, whilst Ceredigion 406th in the UK and last in Wales, with a score of just 16.2%. The report also pointed out that 407th place Eilean Siar, Outer Hebrides in Scotland has a wireless broadband network that was not taken into account in the index meaning that, in all likelihood, Ceredigion has the poorest broadband infrastructure of all UK LAs.

With regards to high-bandwidth services, these are most commonly delivered in Wales through cable infrastructure or via the DSL derivative, ADSL2+ which offers speeds of up to 24Mbps, but is also a distance-dependent technology and will not actually achieve those kinds of speeds for the vast majority of users. Coverage of ADSL2+ in Wales is low, with services only available in a very limited number of exchange areas. This is due to the fact that up until recently ADSL2+ services have only been available through LLU operators and LLU rollouts are usually concentrated in the more profitable densely populated urban areas.

Within rural areas, ADSL2+ coverage is unlikely to be met through LLU due to these areas being economically unattractive for LLU investment. However, BT has recently begun a nationwide rollout of ADSL2+ as part of their 21CN deployment but, whilst this will increase the availability of ADSL2+ services beyond the highly profitable urban areas, those premises that are far from their local telephone exchange will not see a great increase, if any in the speed of their broadband service. Due to the issues regarding line lengths and technological limitations only a relatively small number of households will actually be able to receive a service with a minimum downstream speed at the top end of what ADSL2+ can deliver. According to estimates calculated by thinkbroadband.com using BT Wholesale figures, only around 25% of all UK households will be able to receive an ADSL2+ service with a minimum download speed of 11Mbps and above and with longer average local loop lengths, this figure is likely to be lower again in Wales (Broadband, 2008)

Whilst ADSL by definition has a higher downstream bandwidth than upstream bandwidth, some businesses require greater upstream bandwidth in order to send information over the Internet, such as sending large files and uploading information onto a website. In order to satisfy this demand SDSL (Symmetrical Digital Subscriber Line) services were provided. SDSL has primarily been marketed as a business technology and the high cost of these products reflects the superior service features. These offer the same bandwidth both upstream and downstream, with 522kbps, 1Mbps and 2Mbps services generally offered and typically have a very low contention rate with no usage restrictions.

The contention ratio is the ratio of the potential maximum demand to the actual bandwidth. The higher the contention ratio, the greater the number of users that may be trying to use the actual bandwidth at any one time and, therefore, the lower the effective bandwidth offered, especially at peak times. An ASDL connection usually has a contention ratio between 20:1 and 50:1, meaning that 20 to 50 computers, each assigned or sold a bandwidth of "up to" 1 Mbps could be sharing 1 Mbps of bandwidth. Most SDSL products have a contention ratio of 10:1 or 20:1. Products with 5:1 and 1:1 contention are available, mostly within urban areas, but a lesser variety of products are available elsewhere in Wales.

Within Wales, SDSL is available to around 25% of all domestic and 29% of all non-domestic sites in Wales. This is considerably lower than the UK average which is estimated to be 42% of all sites. BT has ceased its SDSL rollout without explanation and no changes in SDSL availability have taken place since November 2005. No further SDSL rollout is expected (Ofcom, 2008).

The rollout of ADSL Max services means that 8Mbps services are now available throughout most of Wales. This service appeals to many business users because BT's ADSL Max Premium (business) derivative can provide up to 832kbps upstream and has a contention ratio of 20:1. This is compared to the standard consumer service, which offers a 448kbps upload rate and a 50:1 contention ratio. The ADSL Max Premium service has a faster downstream rate than SDSL, and a comparable upstream rate to many SDSL services. Consequently, SDSL services are now less desirable to businesses that do not require the high upload rates and very low contention ratios offered by some SDSL services.

The rollout of ADSL2+ services could further negate the requirement of SDSL as it would provide services offering even greater bandwidths. Current business offerings allow downstream rates of up to 16Mbps and upload rates of 1Mbps. However, service quality and reliability are often more critical to businesses than upload/download speeds alone and, as such, these high contention services may not be ideal for many businesses. For those businesses situated outside of SDSL areas that require high levels of service quality and low contention, a 1:1 contention leased line is often the only alternative and, consequently, an inability to obtain an SDSL service may remain an issue for a small minority of businesses.

With regards to other broadband delivery technologies, Fixed Wireless Access (FWA) broadband is available from a limited number of niche providers in Wales and satellite broadband services are

available throughout Wales. The coverage of DSL technologies in Wales as an affordable access technology for broadband has limited recent use of FWA and satellite to areas that are unreachable by BT exchanges (Ofcom, 2008).

FTTC is now the main fixed-line telecommunication development in the UK, as ADSL has reached its maximum usefulness in terms of speed and commercial rollout potential, and involves laying fibre optic cable from the local exchange to the street cabinet. The link between the cabinet and the customer's premises is provided by Very high speed Digital Subscriber Line [VDSL] which allows data to be transferred at a high speed over the twisted copper wires. The FTTC service provided by BT has an "up to" download speed of 40Mbps with an "up to" download speed of between 10 and 15Mbps. A further development of fibre optic rollout is the higher quality fibre-to-the-premises [FTTP]. In this case, the fibre has a direct connection between the exchange and the premises, thereby offering higher data speeds of "up to" 110Mbps. This is by far a much more expensive option and will require Government financial support to install, with rural areas creating a much heavier financial burden. Nevertheless, FTTP must be the ultimate goal for all UK premises, if physically and economically possible.

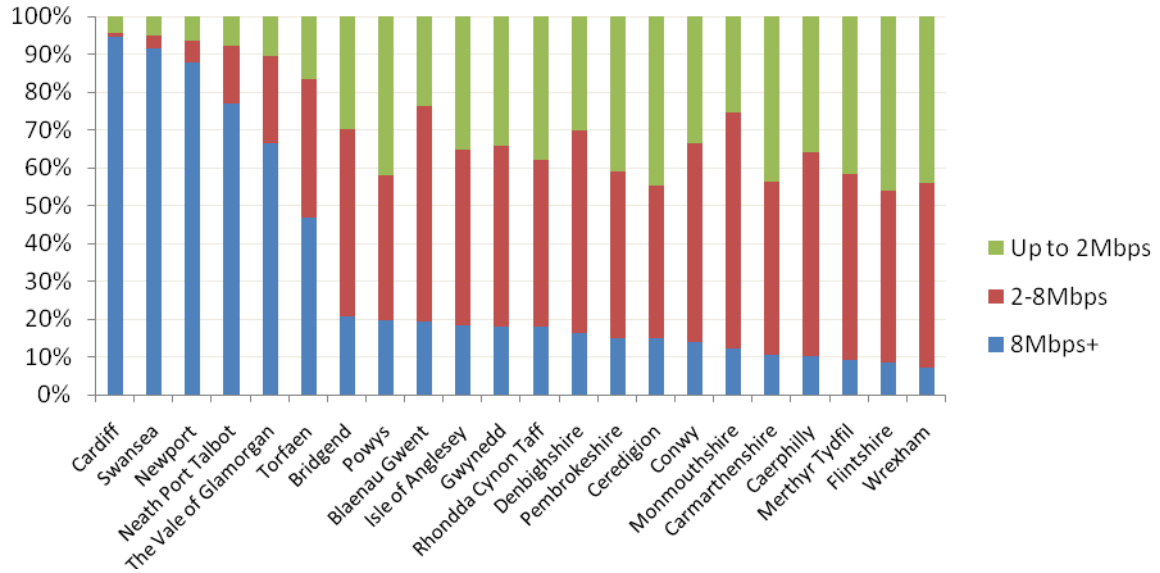


Figure 4.2 – Percentage of households achieving selected download speed rates by Local Authority areas in Wales, Source: Point Topic, 2011

Figure 4.2 gives a clear indication of the difference in broadband speeds achievable between urban and rural areas of Wales. Whilst more than 90% of all households in the Cardiff and Swansea areas can have broadband access at speeds of 8Mbps and above, less than 20% of households can achieve

these speeds in 15 LA areas. Furthermore, within some rural LAs, such as Pembrokeshire, Ceredigion and Flintshire, more than 40% of all households are unable to access broadband at speeds greater than 2Mbps.

4.2.4 Mobile Availability

Mobile communications infrastructure is made up of a network of base stations which use radio frequency channels to provide mobile communications services. In addition to voice services, mobile communications also provide a number of other services including, SMS (Short Message Service) messaging, i.e. text messaging, and data services that allow access to the Internet. There are currently two generations of mobile technology generally being used in the country; 2G and 3G.

2G networks are digital and are based on TDMA (Time Division Multiple Access) and CDMA (Code Division Multiple Access) standards. The main standard used in the UK is GSM (Global System for Mobile communications), which is TDMA-based, and is used mainly for voice communications and SMS. Another commonly used standard is GPRS (General Packet Radio Service), also TDMA-based, which is a packet oriented data service allowing the use of such services as WAP (Wireless Application Protocol), SMS and Internet access. GPRS has also been described as a 2.5G technology as it is considered to be an advancement upon previous 2G technologies. Whilst being capable of providing Internet access, GPRS cannot be considered as a mobile broadband technology as it provides data rates of 56 to 114kbps, which is below the minimum requirements of most broadband definitions.

As well as voice calls, 3G data services can provide a variety of download speeds to end-users from 153kbps up to 2Mbps.3G can therefore be considered as a minimum mobile broadband service but is limited according to coverage. Both 2G and 3G services in the UK are provided by three network operators [Everything Everywhere, O2 and Vodafone]. Across the UK 93.6% of premises have coverage outside the building. Areas known as “mobile not-spots”, where the ability to make phone calls, exchange text messages and access the internet from mobile devices is not possible. These areas are usually in localities of low population, or where the terrain prohibits the propagation of radio signals and are economically unviable to provide a commercial service. There are also areas known as “partial mobile not-spots” where some operators have installed additional masts to overcome the problem of poor propagation, but are not covered by all operators.

4.3 Take-up of Telecommunications Services in Wales

4.3.1 Take-up and Consumption of Fixed-line Services

Take-up of fixed-line services in Wales (80%) is broadly in line with the average UK figure (84%), although the urban take-up is 78% with rural areas at 87%. This is due to the increased use of mobile phones as the sole means of communications by urban dwellers (Ofcom 2012).

4.3.2 Take-up and Consumption of Broadband Services

The take-up of fixed broadband connections in Wales (63%) is lower than the UK average (72%). The urban take-up is 61% and rural 69%. (Ofcom, The Communications Market Report, 2012).

However, there is a marked difference in the levels of take-up of broadband by Local Authority areas in Wales. While the areas surrounding the main Welsh cities of Cardiff, Newport and Swansea are showing high levels of broadband take-up, the remaining areas of Wales have very low levels. Encouragingly, Cardiff ranked as the second highest district in the whole of the UK for broadband take-up, second only to Swindon, with almost 58% of households having broadband access at the end of June 2006. However, the low levels of take-up in North and West Wales, as well as the South Wales valleys, raises concerns of an increasing divide in terms of demand for broadband services between the urban areas around the cities of South Wales and the more rural areas of the country (Point Topic, 2009).

Internet utilization across the UK is 80% with Wales at 74%. There is a distinct difference in the levels of people connected to the internet between those classed in different social grades; 71% of AB social grades connected to the internet compared to 27% in DE social grades. The lack of interest in the internet seems to be the greatest barrier to increased internet penetration rather than economic reasons and, as such, increasing media awareness by providing opportunities for those who are less affluent to experience how the internet can be relevant to their everyday lives may be the best solution for increasing internet penetration levels amongst these groups (Welsh Consumer Council, 2008).

Furthermore, Wales has the highest rate of voluntary exclusion from broadband of all UK nations, indicating that media awareness may be a greater issue in Wales than elsewhere.

Within Wales, some 20% of households are mobile-only, compared to 15% for the UK as a whole, meaning they do not have a landline. Consequently, Wales' higher dependency on DSL for

broadband delivery means that not having a landline could be a barrier to people ordering broadband. Since ADSL is the most popular broadband technology due to price and availability, this could mean that 20% of households may experience problems gaining an affordable broadband service. The difference in mobile-only households between urban and rural areas is also significant with 21% of households in urban areas of Wales being mobile-only compared to 11% in rural areas (Ofcom, 2008).

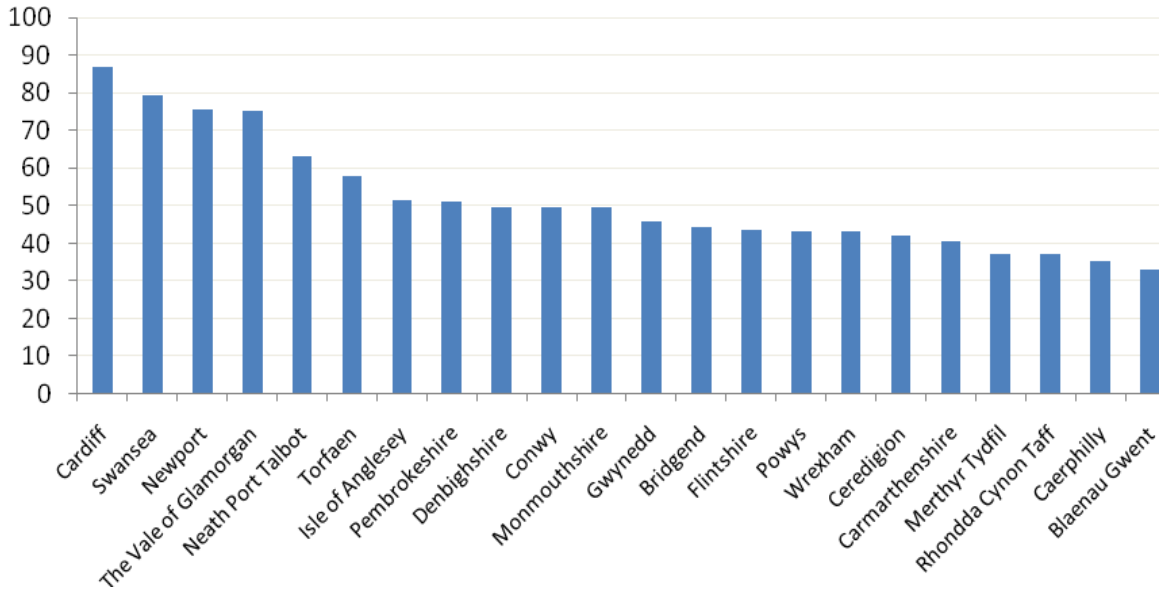


Figure 4.3 – Percentage household take-up of broadband services by Local Authority areas in Wales, Source: Point Topic

Figure 4.3 shows that take-up of broadband services is far higher within the urban centres of Cardiff, Swansea and Newport. The low take-up in areas such as Merthyr Tydfil, Rhondda Cynon Taff, Caerphilly and Blaenau Gwent suggests that these may be areas that should be targeted to make broadband more accessible, and to undertake Media Literacy initiatives to ensure that constituents do not miss out on the social benefits that broadband can provide.

The percentage of households with access to the new FTTC broadband service in the UK during 2011 was 16%, and estimated to rise to 31% in 2012. Corresponding figures for Wales were 1% in 2011 with estimated rise to 17% in 2012. This being the second lowest estimated number of properties amongst the UK regions able to receive FTTC services from BT. The breakdown of estimated figures comparing the rural/urban split shows that across the UK during 2012 was 15/35% (Ofcom, The Communications Market Report, 2012). This again shows that rural areas are lagging behind the populated areas as a result of lower levels of commercial viability. The headline speed of BT's FTTC

service was originally advertised at 40Mbps, but since April 2012 the speed is now advertised as “up to” 80Mbps (Ofcom, 2012).

The FTTP service has relatively few customers to date, with estimation of 50,000 quoted as of end 2011.

BT has announced plans to connect two-thirds of UK premises to either FTTC or FTTP services by the end of 2014.

The expression “superfast broadband” is commonly used with regard to broadband network provision and is defined as connections with headline “up to” speeds of 30Mbps or more (ITU, 2012). In order to appreciate the total fixed-line service provision of superfast broadband, the combined Virgin Media cable service plus BT’s FTTC service needs to be considered (the BT FTTP deployment is considered to be too small a figure for this exercise). Across the UK OFCOM estimates that 60% of homes were able to receive superfast broadband by March 2012, (up from 53% in March 2011), by virtue of BT’s rollout of FTTC, although only 7% have adopted it. Of these homes, 28% were located in rural areas, with urban dwellers totalling 67%. Wales had the lowest estimated proportion of homes able to receive superfast broadband amongst the UK regions at 34%.

4.3.3 Take-up of Mobile Broadband Services

During 2012 the take-up numbers for all mobile users (2G and 3G) was identical between Wales and the UK at 94%. In Welsh urban areas this figure represented 94% with 91% in rural areas. (Ofcom, The Communications Market Report, 2012).

Although some areas in Wales suffer from mobile not-spots or partial mobile not-spots, in general coverage has improved, although the 3G service continues to favour the more densely populated urban areas. Only 0.3% of premises in the UK do not have 2G coverage from any operator. Across the UK 99.7% of premises are covered by 2G, whilst across Wales this figure is slightly less at 99.2%. For 3G services across the UK the coverage is 99.1% with Wales at 97.6%. In terms of geographic coverage, the figures are lower as mobile masts are generally located near centres of population. Areas not covered by any 2G services across the UK equate to 12.8% of the land mass, whilst in Wales this figure is 14.3% (Ofcom, 2012). The areas for 3G geographic coverage for the UK has been estimated at approximately 76%, and for Wales 47% (Ofcom, 2010).

During 2013, 4G, a fourth generation of mobile phone is being introduced to the market. The 4G system provides mobile ultra-broadband internet access to a range of mobile devices, allowing a wide range of applications to be used. These include web access, high-definition mobile and 3D TV, IP telephony, good quality video conferencing and cloud computing.

Two 4G mobile communications standards are being considered for the commercial rollout of this new service. Firstly, the LTE standard has been implemented in the UK by EE[6], on the 11th September 2012, with theoretical data speeds of 100Mbps peak download speed and 50mbps peak upload speed. Secondly, the Mobile WiMAX standard has been adopted in some countries, e.g. South Korea and Russia, with data speeds of 128Mbps peak upload and 56Mbps peak download speeds. Due to EE's early adoption of the former standard, and that this standard has been implemented in the US, Germany, Japan, Australia and Canada, it is likely that LTE will be the preferred standard for the UK (Ofcom, 2013). It is expected that operators will begin to rollout 4G networks during mid 2013 and start offering 4G services by the end of the year.

4.4 Conclusions

This chapter concludes that, whilst broadband access is available to more than 99% of premises in the UK, there are significant differences in the quality of availability in different areas, particularly between urban and rural areas. The most significant determinant of broadband access speed, using the most used access technology DSL, is the distance of premises from their local telephone exchange and 25% of rural premises are more than 5km from their exchange compared to 15% in urban areas. This is an even greater issue within Wales where 18% of all premises are further than 5km from their exchange, compared to 14% in the UK as a whole. This is further exacerbated by the low availability of alternative technologies, such as cable, in rural areas.

Within Wales itself, evidence shows that the Ceredigion local authority area is amongst the worst for provision of broadband infrastructure, whilst the Cardiff area is the best. Further evidence of the disparity in broadband quality is provided by Figure 4.2, which shows that fewer than 20% of

[6] Everything Everywhere Limited [EE] is the mobile network operator and internet service provider joint venture formed between Orange and T-Mobile on the 1st July 2010.

premises in Ceredigion receive download access speeds of 8Mbps or more, compared to more than 90% in Cardiff.

Mobile services also have considerably poorer coverage in rural areas, with 3G coverage sparsely available beyond Wales' main urban conurbations.

There is no doubt that both the fixed-line services and mobile services will improve as FTTC, FTTP and 4G are rolled out during the next few years. Nevertheless, trends are already indicating that the urban areas will be the early adopters, spoilt for choice with a greater number of competing services at increasing data speeds and quality, whilst rural areas will lag behind. Also of concern is that urban businesses are guaranteed these improving services as quickly as the operators are able to provide them, but rural areas will be dependent on Government support and therefore have no reliable projected availability dates to look forward to.

Take-up of broadband and mobile services is also markedly different in urban and rural areas of Wales. Whilst the figures given are for household take-up rather than for small businesses, they do give further indication of the difference in coverage between Cardiff and Ceredigion and also the attitude towards such services in the two areas. Whilst it is not evidenced, it is worth considering that the considerably lower use of broadband in rural areas may well translate to lower levels of media literacy and IT competence in these areas, and this in turn could have an impact on the small businesses in the area who are run by, or employ, people living in their respective areas.

Consequently, Wales is shown to be disadvantaged compared to the UK as a whole in terms of broadband quality and infrastructure provision and, as such, the economic impact of varying quality broadband is of even greater importance than in many other areas of the UK. Furthermore, Ceredigion and Cardiff are shown to be at polar opposites within Wales when it comes to broadband infrastructure quality and provision and are, therefore, ideal areas for comparing the impact of varying broadband quality upon SMEs.

Chapter 5 – Analysis of the Cardiff and Ceredigion areas

5.1 Introduction

The previous chapter considered the telecommunications landscape of Wales and highlighted two areas in Wales which are at opposite ends of the spectrum in terms of broadband provision, namely Cardiff and Ceredigion. Given this disparity, and that the former is an urban area and the latter a rural one, choosing these areas for further investigation enables us to contrast the situation prevailing in urban and rural areas. To provide a greater context to our study, this chapter now considers the two chosen areas in greater detail.

The chapter commences by making a comparative analysis of the Ceredigion and Cardiff areas in terms of their geographic and topological differences and discusses the impact this could have on the broadband infrastructure in the two areas. It then continues by comparing a number of demographic and economic indicators in order to illustrate how the two areas compare in economic terms. The chapter concludes by summarising the geographical, demographical and economic differences between the two areas, indicating why Ceredigion is considered as a rural area in contrast to Cardiff as an urban area.

5.2 Geography and Topology

As shown in Table 5.1, the local authority area of Cardiff consists of a population of 345,500 living in 142,600 households and, as such, is considerably larger in population terms than the local authority area of Ceredigion, which consists of a population of 75,300 people living in 31,600 households (ONS, 2011).

	Ceredigion	Cardiff	Wales
Population	75,300	345,500	3,063,800
Households	31,600	142,600	1,302,700
Businesses	2,945	10,255	88,590
			Source: ONS

Table 5.1 – Population, households and businesses in Cardiff and Ceredigion, 2011

The Unitary Authority area of Cardiff, as shown in Figure 5.1, consists mainly of the relatively flat city of Cardiff and is surrounded by low hills on the outskirts to the East, North and West with coastline to the South. It comprises an area of 139km² with a population density of 2,486 people per km².

Figure 5.1 – Map of Wales highlighting the geographical location of Cardiff Unitary Authority

Cardiff's proximity and easy access to the coal fields of the South Wales valleys was influential in its development as the world's largest coal port, and this has lead to it eventually becoming the capital city and economic centre of Wales.

Ceredigion is situated on the West coast of Wales, as shown in Figure 5.2, bordered by Cardigan Bay to the west, Gwynedd to the north, Powys to the east, Carmarthenshire to the south, and Pembrokeshire to the south-west. It comprises an area of 1,792km² and the population of the county at the 2011 census was 75,300. Ceredigion has a population density of 42 people per km². The main settlements within Ceredigion are Aberaeron, Aberystwyth and Cardigan (ONS, 2011).

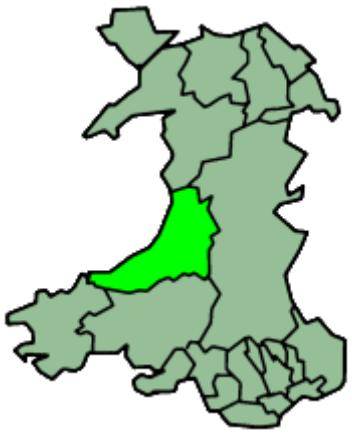


Figure 5.2 – Map of Wales highlighting the geographical location of Ceredigion Unitary Authority

Much of the east of the county is covered by the Cambrian Mountains; an area which forms part of the 'desert of Wales', a large area in central Wales so called because of its lack of roads and towns and its inaccessibility, whilst the west of the county is less elevated with 50 miles of coastline.

Despite its small population, Ceredigion has two universities within its county boundaries: Aberystwyth University and the University of Wales, Lampeter as well as The National Library of Wales, founded in 1907, and located in Aberystwyth. However, the county lacks any large commercial areas and is isolated from any major economic hubs. The nearest substantial settlements are located at least 1 hour 45 minutes drive away. From the largest town, Aberystwyth: Swansea, to the south, is 70 miles away; Shrewsbury, in Shropshire, England, to the east, is 75 miles away; and Wrexham, to the north, is approximately 80 miles away. The capital, Cardiff, is over 100 miles away from most regions of the county.

Cardiff has experienced significant investment in ICT infrastructure in recent years, with the city and wider region being well served by modern communications. Many industries covered by this sector have moved from high volume production to specialist, lower volume, high value-added production. Such research and development (R&D) activity is anticipated to be the strongest driver of economic growth in the sector. Communications and Computing Services are expected to grow by 3.75% and 3% respectively between 2006 and 2016 and, furthermore, this is the type of sector that is likely to attract other high technology firms to the area leading to agglomeration benefits (Cardiff County Council, 2009).

Geography and topology do not provide many challenges to infrastructure deployment in the Cardiff area. However, civil costs of deployment of new infrastructure will be high due to it being a built up area. Nevertheless, despite the high costs of deployment, cost per user will be lower than in a rural area such as Ceredigion. Local loop lengths are on average shorter in areas of high population density such as Cardiff. However, there are areas within the region, e.g. Roath, that are far from their nearest telephone exchange and hence have long local loop lengths. As such, these areas have poor broadband service or even no broadband service at all so these issues are not confined to rural areas alone.

5.3 Economic Demographics

In order to gain an overview of the economic performance of the two regions, this chapter discusses a selection of economic indicators. One of the most widely used indicators of regional economic performance is Gross Value Added[7] (GVA) per head which policymakers often use as a headline indicator of regional productivity and of regional incomes when comparing and benchmarking regions that differ in geographical size, economic output and population. GVA per head is calculated as the simple ratio of the economic activity in a region divided by the number of people living in a region.

	South West Wales	Cardiff and Vale of Glamorgan	Wales
GVA by measure (£ million)	12,853	10,050	47,340
GVA £ per head	13,097	21,366	15,696
GVA per head (indexed to UK = 100)	62.7	102.4	75.2
			Source: ONS

Table 5.2 – GVA per head as a percentage of UK as a whole, 2011

Table 5.2 shows the low GVA per head of population figure for Ceredigion in comparison to that of Wales. As a percentage of the UK as a whole, the GVA per head in South West Wales (a NUTS3[8] area consisting of Ceredigion, Carmarthenshire and Pembrokeshire) is 62.7%, whereas for Wales nationally the figure is a considerably higher 75.2% and for Cardiff and the Vale of Glamorgan it is 102.4%. This would suggest that the Ceredigion area is, economically, not only far behind the UK average but also further behind Cardiff and the Vale of Glamorgan.

GVA is a good measure for the economic output of a region. However, due to the erratic nature of GVA data, it is not statistically viable to produce individual estimates for each category of the LA classification for every region for individual years, because the individual categories in some regions have too few data points on which to base robust estimates. Furthermore, there are other indicators

[7] GVA – Gross Value Added: A measure of the value of goods and services produced in an area, industry or sector of an economy.
[8] NUTS – Nomenclature of Territorial Units for Statistics

that can better illustrate the income of a region. For example, due to commuting, residents might derive their incomes from economic activity in another region, which is not captured by the GVA per head of their region. They may also have sources of income which are unrelated to current work, such as pensions and investment incomes. Consequently, Gross Disposable Household Income (GDHI) per head is a better measure of regional incomes than GVA per head and gives an indication of the welfare of residents living in a region.

GDHI is a residence-based measure and represents the amount of money available to households after taxes, National Insurance and pension contributions, property costs and other interest payments have been deducted. These estimates are at current basic prices and do not take inflation effects or regional price differences into account. In order to make reliable comparisons of regional income levels, the analysis needs to take account of relative population sizes of regions.

	Ceredigion	Cardiff	Wales
Gross weekly pay (Full-time workers, £, ONS Annual survey of hours and earnings 2012)	416.0	494.4	455.0
Gross disposable household income (£ per head, STATSWALES 2011)	13,975	14,740	14,129
			Source: ONS

Table 5.3 – Gross weekly pay and job density, 2011/12

Further proof of the economic status of Cardiff can be seen in the high average gross weekly pay of full-time employees, as shown in Table 5.3. Within Cardiff this stands at £494.40 per week, considerably more than the national average of £455.00 per week. The gross weekly pay for full-time workers in Ceredigion is £416.00 per week, as shown in Table 4.3. This is considerably lower than the national average and lower still than the average in the Cardiff area.

Table 5.4 shows that within the Cardiff area, 68.5% of the population are of working age, whereas in Ceredigion 64.3% of the population are of working age. Both areas are above the Welsh national average of 63.4%.

	Ceredigion	Cardiff	Wales
Working age population (% of all persons)	64.3	68.5	63.4
Employments rates (% of working age population, ONS Annual Population Survey Jan 2012-Dec 2012)	60.3	64.2	67.3
Job density (Ratio of total jobs to working age population, ONS Jobs density 2011)	0.73	0.91	0.70
			Source: ONS

Table 5.4 – Working age population, employment rates and job denisties in Ceredigion and Cardiff, 2011

Job density in Cardiff, i.e. the ratio of total jobs to working age population is 0.91, is considerably higher than that for Wales as a whole at 0.70, as shown in Table 5.4. This figure is unsurprising due to Cardiff being regarded as the main economic hub of Wales.

In terms of the economically active, Table 5.5, shows that the economically active population is considerably higher in Cardiff (72.1%) than in Ceredigion (62.7%). Both areas, however, are lower in comparison to the national population, which shows that 73.5% of the Welsh population is economically active.

Overall, 64.2% of the Cardiff population are in some form of employment, compared to 63.4% in Wales as a whole. Meanwhile, 64.3% of the population in Ceredigion are in some form of employment. As such, the job density in Ceredigion is 0.73 jobs per working age population. Whilst this is considerably lower than in Cardiff it is in line with national figures. Job density in line with national figures and low levels of unemployment suggest that the economy in Ceredigion is performing well.

	Ceredigion	Cardiff	Wales
Economically active population (% of all persons, ONS annual population survey Jan 2012-Dec 2012)	62.7	72.1	73.5
In employment (% of all persons, ONS annual population survey Jan 2012-Dec 2012)	60.3	64.2	67.3
Employees (% of all persons, ONS annual population survey Jan 2012-Dec 2012)	47.0	57.1	58.0
Self-employed (% of all persons, ONS annual population survey Jan 2012-Dec 2012)	12.6	6.9	8.7
Unemployed (% of all persons, ONS annual population survey Jan 2012-Dec 2012)	5.6	10.3	8.3
			Source: ONS

Table 5.5 – Breakdown of economically active populations, 2012

There are stark differences in the proportion of self-employment between Cardiff and Ceredigion. Levels of self-employment in Cardiff are relatively low with only 6.9% of the population registered as self-employed, compared to 8.7% in Wales as a whole. These figures are both considerably lower than in Ceredigion where 12.6% of all persons are self-employed. Consequently, the number of employees of businesses is considerably higher in Cardiff (57.1%) than in Ceredigion (47.0%). Contrastingly, the unemployment level in Cardiff is higher than that for the national population with 10.3% of the Cardiff population considered to be unemployed compared to just 8.3% nationally. The unemployment level in Ceredigion is very low with only 5.6% of the population unemployed.

VAT Registered Businesses (% of all stock, BERR 2007)	Ceredigion	Cardiff	Wales
Registrations	5.0	9.7	7.8
De-registrations	5.0	7.6	6.3
			Source: BERR

Table 5.6 – VAT registered businesses, 2007

There is also evidence that the economy in the Cardiff area remains strong with the number of new VAT registered business registrations outweighing the de-registrations. According to Table 5.6, in 2007 the new registrations of VAT registered businesses in the Cardiff area stood at 9.7% of all stock,

compared to 7.6% in de-registrations. However, this also suggests that there is a relatively high churn in businesses in Cardiff with many businesses having a short lifespan.

New registrations of VAT registered businesses are also outpacing de-registrations in Wales nationally. In 2007, the new registrations of VAT registered businesses in Wales stood at 7.8% of all stock, compared to 6.3% in de-registrations. According to figures from BERR, new registrations and de-registrations of VAT registered businesses in the Ceredigion area were both at 5.0% of all stock. Whilst this may be considered an underperformance in terms of creating new businesses, compared to national figures and to Cardiff, where new registrations are outpacing de-registrations, this does also indicate a low level of churn which suggests that the lifespan of businesses in Ceredigion may be longer than in other areas of Wales and hence, whilst the number of businesses may not be growing, they are relatively stable.

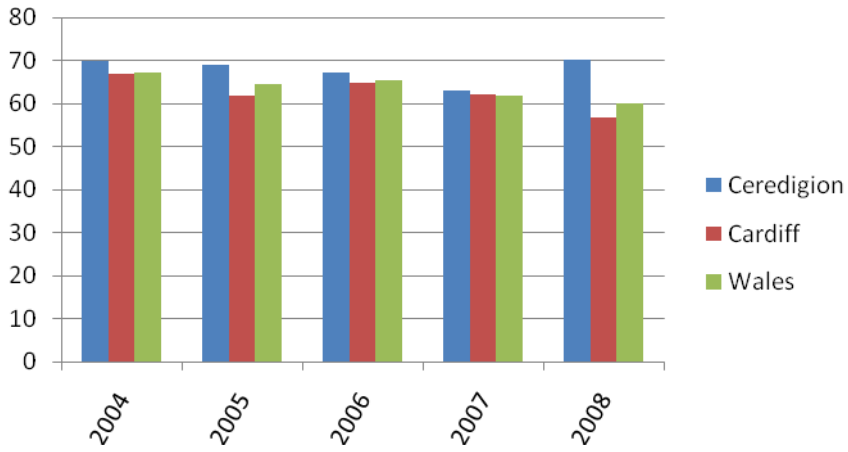


Figure 5.3 – Three year survival rates of new businesses born between 2004 and 2008 in Cardiff and Ceredigion, 2011, ONS

Figure 5.3 shows that three year survival rates for new businesses born from 2004 to 2008 are consistently higher in Ceredigion than in Cardiff. This supports the analysis that businesses in Ceredigion tend to be more stable, whilst there is a relatively high churn in businesses in Cardiff with many businesses having a short lifespan.

These results could suggest a greater level of innovation in Cardiff, with more people willing to invest in creating new businesses. This could be particularly relevant to the new technologies sector where businesses have a tendency to be low cost in terms of setting up but, due to competing in a fast developing industry, also tend towards a higher degree of churn.

With regards to jobs by industry sector, Table 5.7 shows that 87.9% of all employee jobs in Cardiff and 87.3% of all employee jobs in Ceredigion are within the services sector.

Employee jobs by industry sector (% Total employee jobs, ONS Annual business inquiry employee analysis 2008):	Ceredigion	Cardiff	Wales
Manufacturing	5.9	5.9	13.7
Construction	5.0	6.0	5.2
Services	87.3	87.9	79.1
Distribution, Hotels and Restaurants	28.0	20.4	23.0
Transport and Communications	3.3	4.9	4.3
Finance, IT and other business activities	8.8	25.5	14.1
Public admin, Administration and Health	41.5	30.9	32.9
Other Services	5.7	6.2	4.8
Tourism related	13.2	8.2	8.6
			Source: ONS

Table 5.7 – Employee jobs by industry sector, 2008

Whilst the figure for construction is relatively similar for Wales as a whole, the percentage of employees in the manufacturing and services sectors varies greatly. There are far more manufacturing jobs in Wales nationally than in Cardiff, with manufacturing accounting for 13.7% of all jobs in Wales, whilst the number of jobs in the services sector is considerably lower nationally at 79.1% of all jobs. With regards to jobs by industry sector, 87.3% are within the services sector, with 5.9% in manufacturing and 5.0% in construction. This shows that there are far fewer jobs in the manufacturing and construction sectors in Ceredigion than there are nationally. Consequently, Ceredigion is heavily reliant upon the services sector for its employment, even more so than Cardiff, which is also highly reliant upon the services sector.

	Ceredigion	Cardiff	Wales
Soc 2000 major group 1-3	39.1	47.6	37.7
1 Managers and senior officials	13.5	12.4	13.1
2 Professional occupations	12.5	19.1	11.4
3 Associate professional & technical	13.1	16.2	13.2
Soc 2000 major group 4-5	29.3	21.7	24.0
4 Administrative & secretarial	8.4	13.4	11.1
5 Skilled trades occupations	20.9	8.3	12.8
Soc 2000 major group 6-7	13.4	16.4	17.2
6 Personal service occupations	9.3	7.7	9.1
7 Sales and customer service occupations	4.2	8.7	8.1
Soc 2000 major group 8-9	17.7	14.0	20.9
8 Process plant & machine operatives	4.7	4.5	7.2
9 Elementary occupations	13.1	9.5	11.5
Source: ONS Annual Population Survey			

Table 5.8 – Types of occupations in Ceredigion and Cardiff by Soc major groups, 2011

With regards to the type of employment in the areas, as shown in Table 5.8, Cardiff has a greater proportion of jobs in the Soc 2000 major group 1-3, which partly explains the higher average wages reported in Cardiff.

5.4 Conclusion

There are very clear differences between the regions of Ceredigion and Cardiff. Whilst being geographically larger, Ceredigion has a very low population in comparison to Cardiff and, consequently, its population density is considerably smaller. This is significant when considering the deployment of new telecommunications networks since, as reported by the Broadband Stakeholder Group: “all access networks require some degree of new passive/civil infrastructure” (Broadband Stakeholder Group, 2008). This accounts for a significant proportion of the capital investment involved in such an undertaking. Areas with low population density will therefore have a lower number of premises connected per unit of capital investment and, consequently, will be less economically attractive for such an investment.

Cardiff can be considered far stronger in economic terms than Ceredigion. The GVA in the Cardiff and the Vale of Glamorgan area leads that of Ceredigion by a significant margin, whilst further evidence is gained by the greater job density and higher wages reported in the area, as well as the higher Gross Disposable Household Income.

In terms of the respective areas' employment base, both are heavily reliant upon the services sector with a greater proportion of employees being employed in this sector than in the average for Wales. Similarly, both areas have less employment in the manufacturing sector than in the Welsh average. Within the services sector however, there are noticeable differences in the type of employment in the two areas. Cardiff has far greater employment in the Finance, IT and other business activities and Transport and Communications sectors, whilst Ceredigion has greater levels of employment in the Public admin, Administration and Health and Distribution, Hotels and Restaurants sectors. Ceredigion also has a greater proportion of tourism related employment. These sectors consist of predominantly smaller and self-employed enterprises which need to communicate their services to a wide range of geographically located customer base in order to survive. The use of electronic commerce and therefore the reliance on good telecommunications service provision is crucial to their ongoing viability.

With regards to the type of employment in the areas, Cardiff has a greater proportion of jobs in the Soc 2000 major group 1-3, which partly explains the higher average wages reported in Cardiff.

Other significant differences are the higher proportion of self-employed persons, the very low unemployment and the low churn in new businesses in Ceredigion. These suggest that whilst Ceredigion's economy is not strong in GVA or average wages, the economy is stable.

Having set out the geographical and economic differences in the chosen regions, the next chapter will focus on appropriate methodologies for studying the impact of broadband quality upon SMEs in these regions.

Chapter 6 - Methodology

6.1 Introduction

Having described the broadband services available to SMEs in rural and urban areas in Chapter 4, and in order to develop an understanding of whether rural SMEs are disadvantaged, it is necessary to consider what is meant by disadvantage and how it can be measured. SMEs can be disadvantaged by a number of factors, including: access to business services and finance, business support, labour market/training, property, transport and communications infrastructure. These factors all affect the competitiveness of SMEs. As such, when considering disadvantage, the issue being addressed is whether SMEs in rural areas suffer competitive disadvantage relative to SMEs located in urban areas.

This chapter outlines the methodology used in this research study, which comprises a mixed method approach of gathering quantitative data via a survey which will be used as a foundation for the collection of detailed qualitative data through the use of case studies. A model giving a graphical depiction of the methodology outlined in this chapter is provided by Figure 6.1 which shows how all the individual parts of the research project fit together and the route taken from beginning to conclusion.

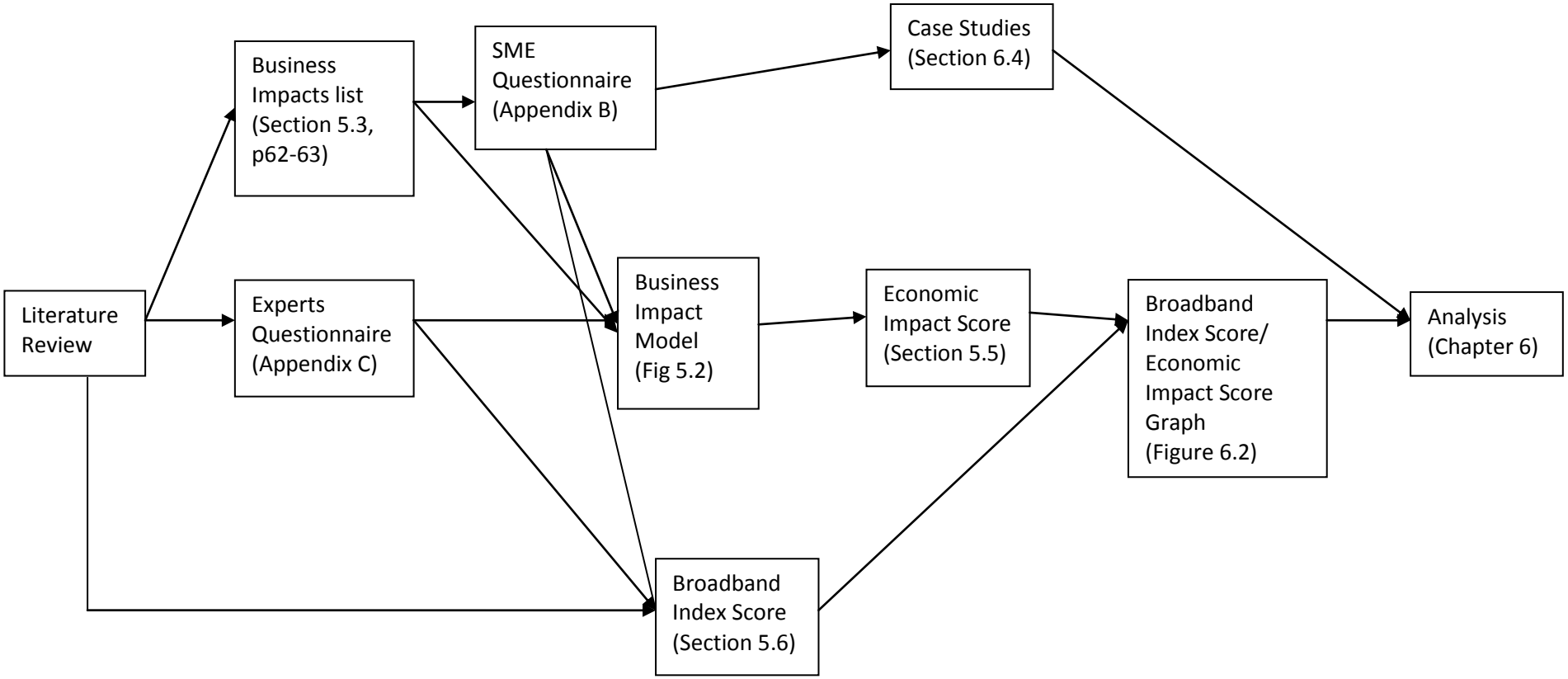
From the review of available literature, a list of benefits and business functions impacted by broadband is created. This list is then used to create a model showing how broadband has an overall economic impact upon a business through these varying benefits and functions. The list is also used to create a survey to be sent to SMEs that will provide the data for inputting into this model. The output of this model is the Economic Impact Score, which will be a numerical representation of the level of economic impact achieved through broadband for comparison between SMEs.

The literature review will also provide the basis for a methodology for measuring the varying quality of broadband service received by SMEs in the study. This will include the creation of another survey to be sent to subject experts that will assist in creating a weighting for a Broadband Index Score. This score will then be plotted against the Economic Impact Score in order to ascertain whether there is any correlation between the two. The hypothesis of this study is that there will be a positive link between the BIS and EIS, i.e. as the BIS increases so will the EIS, providing evidence that as broadband quality increases so will the economic benefits achieved by SMEs.

The data collated from the SME survey will provide the information and issues to be examined in greater depth during the following case studies. These case studies will, in turn, provide the detailed qualitative data to further the information gathered in the surveys which will support the analysis of the study.

The results of the study based on the use of this methodology will be presented and analysed in Chapter 7.

Figure 6.1 – Methodology Model



6.2 Determining Disadvantage

When addressing disadvantage, two separate issues need to be considered, i.e. the differences attributed to geographic location itself, and determining whether the magnitude of these differences represents disadvantage.

In order to assess the attribution of geographic location, comparisons must be made between SMEs located in rural and urban areas. The approaches to attributing differences to geographic location can be divided into ex ante and ex post. An ex-ante approach would involve investigating characteristics of SMEs prior to selecting them for inclusion, whereas an ex-post approach would involve adjusting for characteristics at the analysis stage.

Possible approaches include:

Ex-ante

- Matched pairs design – match SMEs by key characteristics and test for differences.
- Cluster design – select clusters and then select businesses at random from within these clusters and test for differences between clusters through case-based analysis.

Ex-post

- Weighted analysis – weight results by characteristic (i.e. size) and test for differences.
- Regression analysis – control for effects of characteristics by treating them as independent variables in a regression analysis.

An appropriate method of determining true disadvantage for this study could be to undertake a 'matched-pair' study to compare 'like with like', i.e. compare SMEs in rural and urban areas that have similar characteristics. Consequently, any differences could then be attributed to their geographic location. By matching SMEs from rural and urban areas in terms of their characteristics and comparing differences attributed to geographic location it would be possible to determine any competitive disadvantage attributable to geographic location.

An alternative method would be to adopt a cluster design and select clusters of SME types and then select individual SMEs at random from these types.

An example of a study that has used matched pair designs, matching rural and urban businesses before analysis is Patterson and Anderson (2003). This study matched for sector, size, age and ownership, which allowed control for the effect of these factors, before testing for differences between urban and rural businesses.

Having established the attribution to geographic location, there is then a further requirement to assess whether the differences evidenced represent disadvantage. In determining disadvantage, similarities and differences in the characteristics of SMEs in rural and urban areas must be established and the issues facing SMEs must be assessed in order to determine the magnitude of difference that represents disadvantage.

However, the ability to undertake a matched pair analysis will be dependent upon there being appropriate businesses to compare in the survey sample. As such, a non-probability sampling method must be considered in order to increase the likelihood of there being businesses in the sample that can be compared in a match pair study. The following non-probability sampling methods could be considered appropriate for such a study:

Purposive sampling (Lavrakas, 2008) - the sample is based upon who the researcher thinks would be appropriate for the study. This is used primarily when there are a limited number of people that have expertise in an area being researched. This could be applied by selecting only businesses that are similar enough to be directly compared in a matched pair study. Whilst this would be advantageous for analysis, it would also greatly limit the number of businesses that could be approached to take part in the study.

Snowball sampling (Given, 2008) - the survey is sent to a participant who then refers an acquaintance. This person then refers another acquaintance, and so on. This could produce matched pairs as many businesses will have similar businesses to themselves within their network. However, such samples are biased because they give people with more social connections an unknown but higher chance of selection. It could also result in a geographical bias whereby participants refer people who are located nearby. Since urban areas are more densely populated by businesses this could lead to a greater proportion of participants in the sample being based in more urban areas which will result in a major disadvantage in a study that is comparing urban and rural based businesses.

For ease of distribution of the survey, which is hosted online, the sample will be targeted at businesses that have an email address. These will be indentified via business directories supplied by each Local Authority and through other web based business directories. This type of sampling is an example of convenience sampling, a statistical method of drawing representative data by selecting subjects because of the ease of their volunteering or selecting units because of their availability or easy access. The advantage of this type of sampling is the availability and the quickness with which data can be gathered. The disadvantages are the risk that the sample might not represent the population as a whole, and it might be biased by volunteers (Lavrakas, 2008). However, since having access to a broadband service is necessary for participation in the survey this risk is not great and the method will reduce the likelihood of surveys being sent to businesses who don't have broadband access, as those who have an email account are more likely to have broadband than those who do not.

In order to ensure that the sample size is as large as possible for the survey no further specific sampling method will be used for this part of the research. This will also ensure that the sample is as representative as possible of all SMEs, whereas some of the other sampling methods could lead to certain locations and industry sectors being favoured more heavily than others.

6.3 Broadband Business Impact Model Development

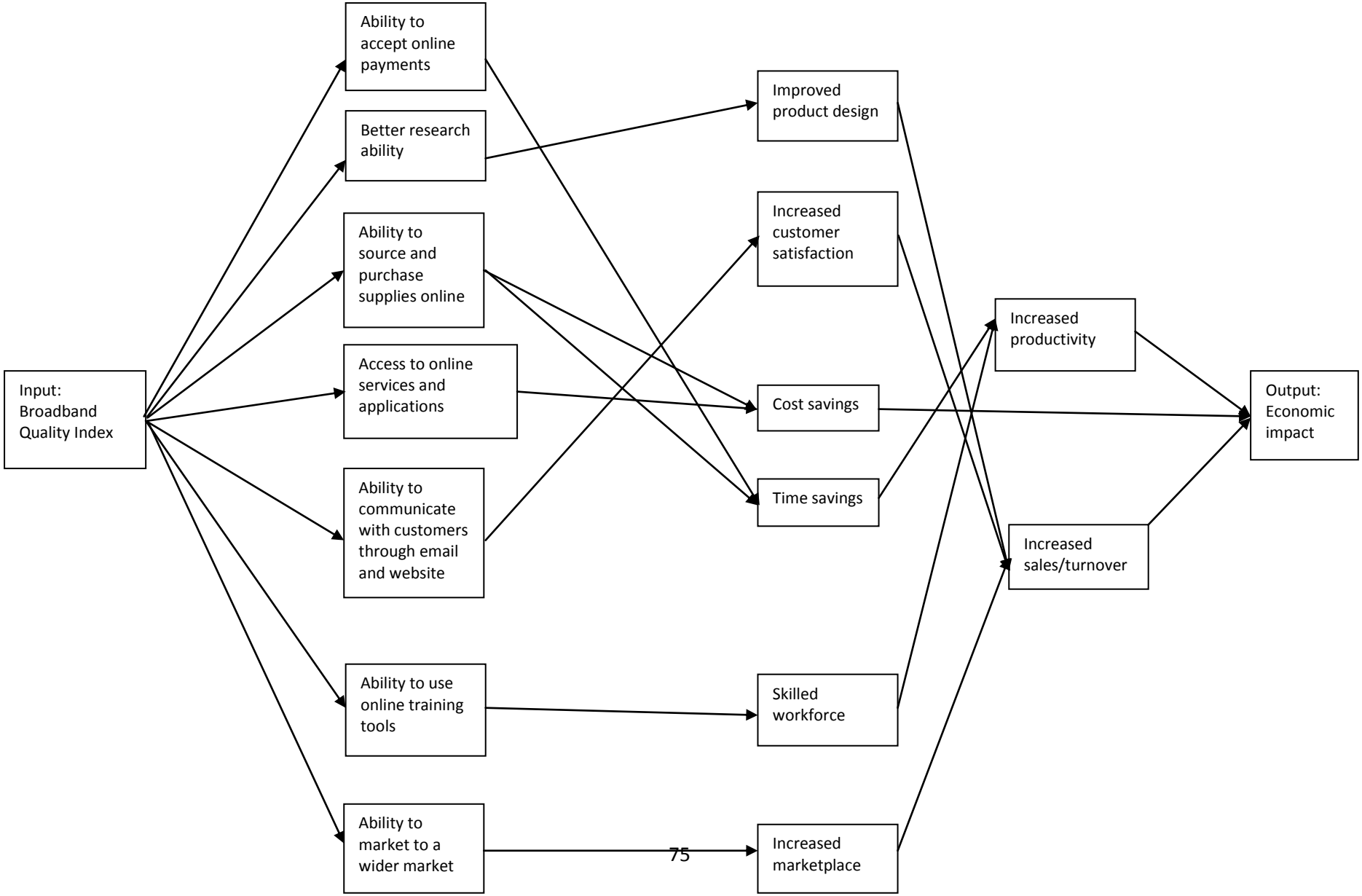
Evidence of the economic impact of broadband within individual SMEs exists in many case studies. These include case studies undertaken by the Welsh Assembly Government (WAG, 2006). These case studies list the numerous key benefits attributable to broadband access achieved by both SMEs from various industry sectors and consumers. The benefits achieved by businesses are identified in the business impacts list:

- Equality of opportunity
- New ways to work
- New business openings
- Lower online costs
- Less administrative overheads
- Increased productivity
- Better customer service

- Global communication
- Professional image
- Improve efficiency
- More effective marketing
- International networking
- Improved collaboration
- Reduced travel and costs
- Faster business processes
- Supply chain integration
- Cheaper purchasing online
- Availability of new markets/wider marketplace
- Location independency
- Competitive advantage
- Greater reliability
- Direct cost savings for Internet access
- Flexible workforce
- Research resources
- Improved processes
- Improved knowledge sharing
- Better market research

Many of these key benefits can have an indirect and/or direct economic impact on a business. In order to understand how these benefits can impact an SME, a Broadband Business Impact Model is shown in Figure 6.2. This figure identifies the primary and secondary links between the benefits attributable to broadband access and provides an overview of how these benefits can have a resultant economic impact upon an SME.

Figure 6.2 – Broadband Business Impact Model



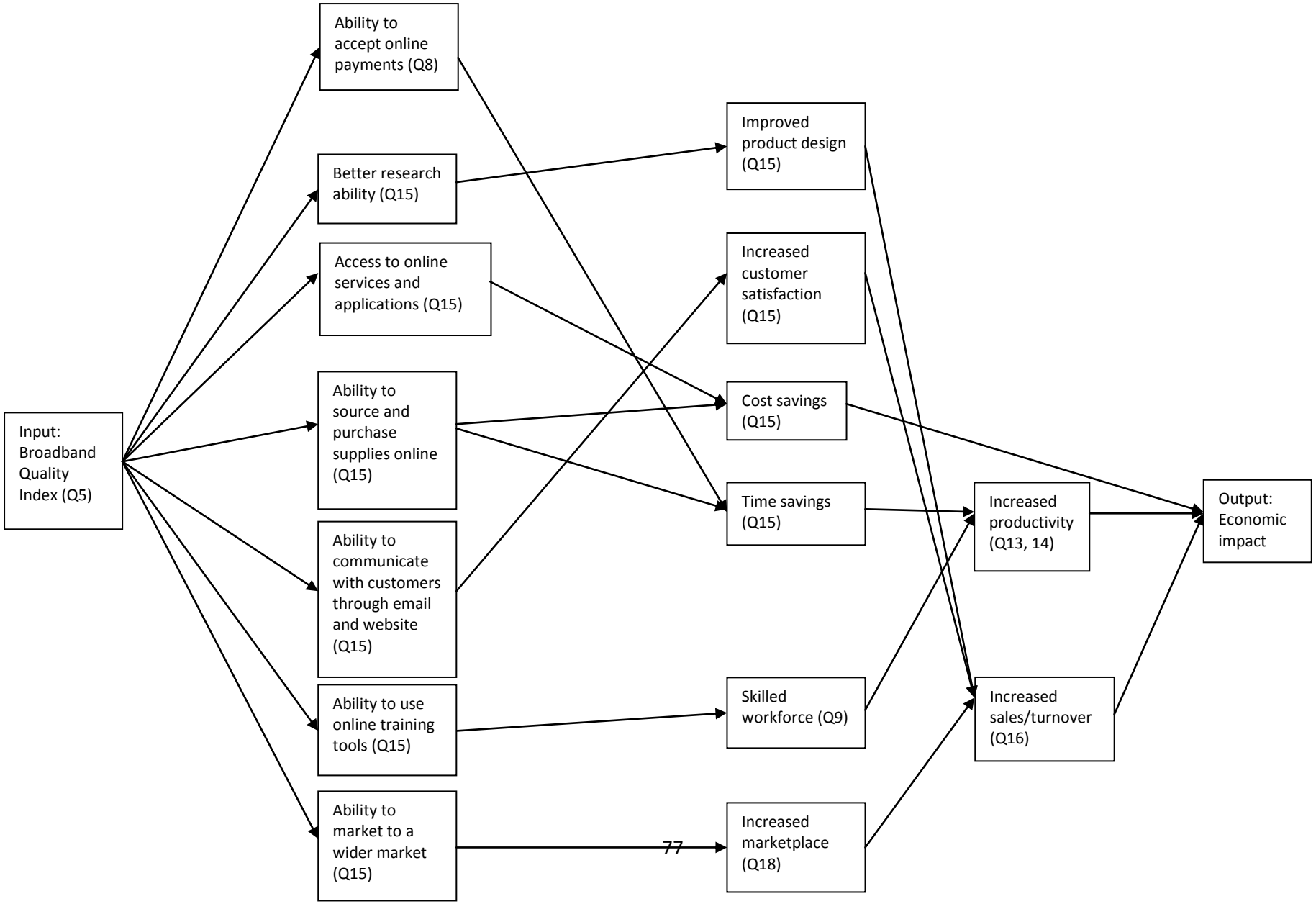
6.4 SME Questionnaire Development

In order to further explore this Broadband Business Impact Model and the impact that broadband quality has had on SMEs, a questionnaire was created.. The first part of the questionnaire collates basic information about each business, i.e. their email address, the postcode of the premises used whilst completing the questionnaire, industry sector and number of employees. The second section relates to the broadband service used by the SME and collates the information required to take a measurement of the quality of their broadband service. The remainder of the questionnaire is developed using the Broadband Business Impact Model seen in Figure 6.2. Each section of the model is represented by a question in the questionnaire as seen in Figure 6.3.

The questionnaire was tested by undertaking a dummy run with an SME located in a 'neutral' area of Wales, i.e. not in Cardiff or Ceredigion, and any issues highlighted were taken into consideration and the questionnaire was modified accordingly. Furthermore, the questionnaire was also forwarded to members of Ofcom UK and Ofcom Wales seeking their advice which was also taken into consideration when developing the final questionnaire, which can be viewed in Appendix B.

As well as providing the data for input into the Economic Impact Score, which will be explained in section 6.5, the data from the questionnaire will also be used to identify businesses to be selected for further case study research and will also inform the issues to be highlighted and discussed in further detail during these case studies.

Figure 6.3 – Broadband Business Impact Model with relationship to SME questionnaire



6.5 Economic Impact Score Methodology

The output for the Broadband Business Impact Model (Figure 6.2) is the economic impact created by the effect of broadband upon the business functions in the model. In order to compare impacts between SMEs with varying quality broadband service an index score is developed, the Economic Impact Score (EIS). Figure 6.3 shows the relationship between each business function and its related question in the SME survey. Respondents were asked to choose from five possible responses to all questions related to this model: strongly agree, agree, neither agree nor disagree, disagree, strongly disagree.

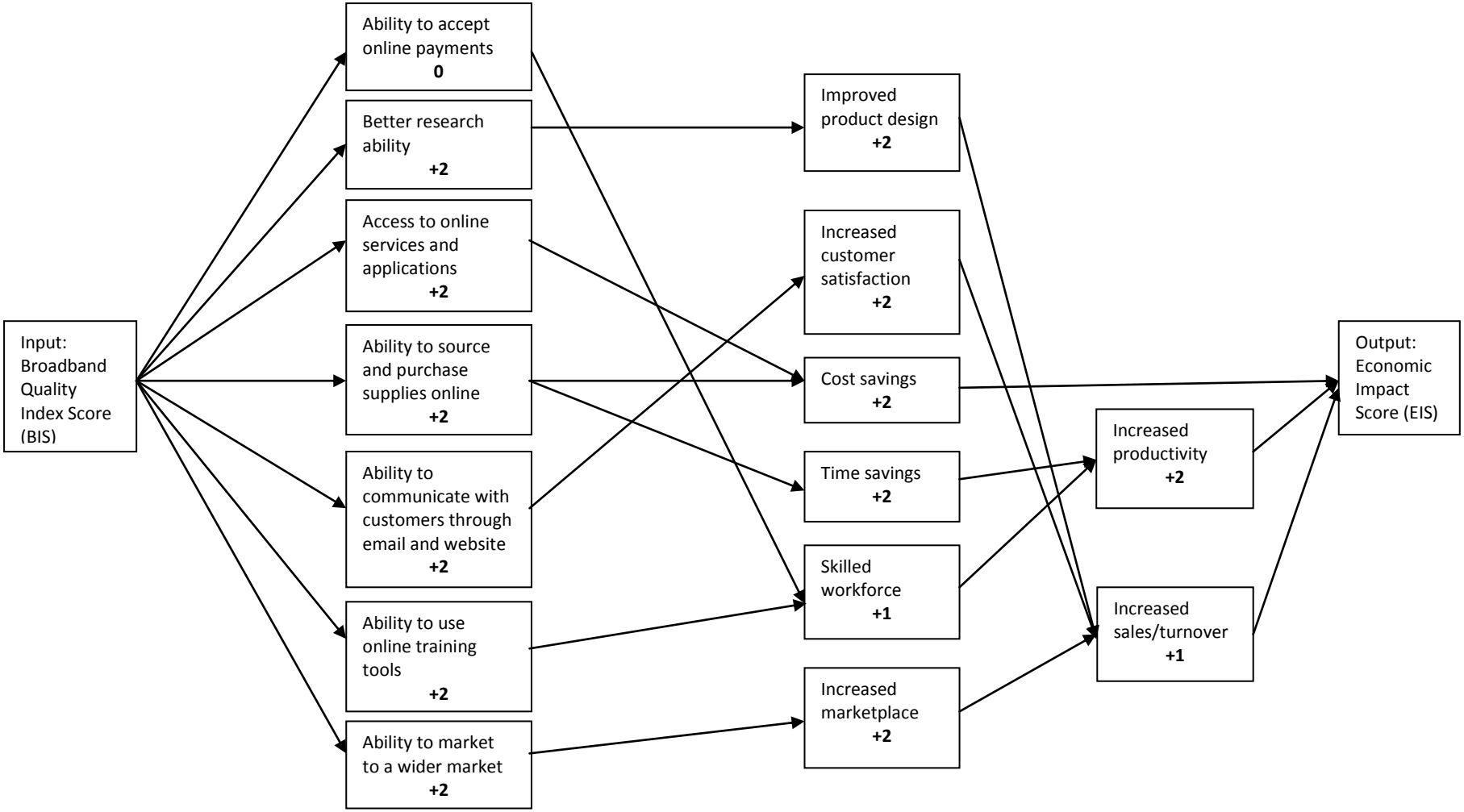
In order to transform the responses to each question into an overall EIS, each answer was given a value as follows:

- Strongly agree +2
- Agree +1
- Neither agree nor disagree 0
- Disagree -1
- Strongly disagree -2

The business functions and impacts chosen for the impact model and, hence, the EIS, all have varying economic impacts that result in a final output. Consequently, it is important to reflect this variance in each function in terms of its relative importance within the index by giving the data points a weighting. Weighting involves emphasising the contribution of some aspects of a data set to a final result, giving them greater weight in the final analysis. Therefore, rather than each variable in the data contributing equally to the final result, some of the indicators were adjusted to provide a greater contribution than others. In this instance, rather than weight each individual data point, the scores were aggregated for each column and a weighting appointed for each of these columns.

As shown in the example provided in Figure 6.4, the first column is given a weighting of 20%, the second 30% and the final column 50%. This reflects the fact that impacts such as increased productivity and increased sales/turnover will have the greatest effect upon overall economic impact, whilst the business impacts in the middle column are likely to have a greater impact than access to the business functions in the first column.

Figure 6.4 – Example EIS results for SME



Whilst these weightings are based on the author's opinion and discussions with case study SMEs, varying these weightings showed a negligible difference to the final results and, therefore, a more robust method for selecting the weighting is deemed unnecessary. The weighted figures are then aggregated to provide a final EIS score for each SME.

The EIS score for each SME will be plotted against the BIS score (see section 6.6) and used to ascertain whether there is any correlation between the two, and henceforth, any correlation between broadband quality and economic impact.

6.6 Broadband Index Score Methodology

Differences in broadband provision are visible not only in terms of penetration rates but also in coverage, speeds, prices and level of usage, as a result of competition and other socio-economic factors. Consequently, the overall patterns of broadband development in Wales are increasingly fragmented. Close monitoring of broadband markets, taking into account all relevant variables, is crucial to provide a fair, reliable picture of how the broadband market is evolving in different areas of the country.

Broadband coverage and penetration have, so far, been the main benchmarks for setting broadband objectives. These usually indicate the number of premises that are connected to a broadband enabled exchange and total broadband lines divided by the population of the area. However, this indicator does not provide any information on the quality of broadband access to which users subscribe. The broadband debate is now evolving from coverage towards quality. Until now quality has not been explored comprehensively, yet it is the most important factor in ensuring a positive experience on the web. Furthermore, it is likely to become increasingly important as the next wave of web applications demand a step-improvement in broadband quality. Close monitoring of broadband markets, taking into account all relevant factors, is crucial to provide a fair, reliable picture of how the broadband market evolves in different areas.

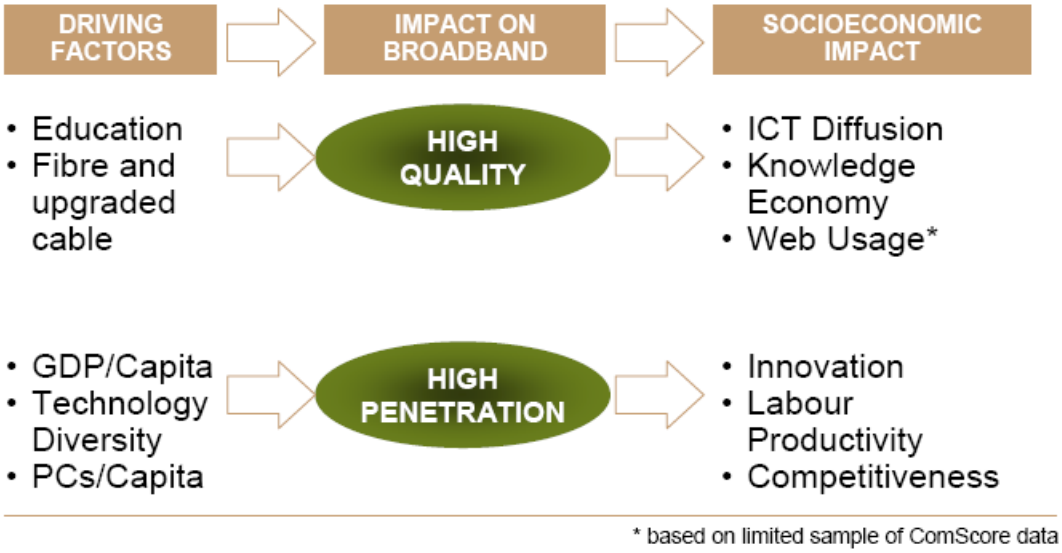


Figure 6.5 – Main impact factors of broadband quality and penetration, Speed Test database; University of Oviedo and Oxford Team Analysis, August 2008

Figure 6.5 shows the varying socio-economic impacts that arise from high penetration of broadband services as well as access to high quality broadband services. This indicates that providing a broadband service is not enough on its own and that high quality broadband must be provided in order to maximize the productivity gains that broadband can achieve. But how can we measure the quality of broadband performance? The following sub-section reviews indices that have been used previously for measuring broadband performance in order to explore the most appropriate methodology for use in this study.

6.6.1 Review of Indices

Ireland Internet Performance Index

The Ireland Internet Performance Index (2008) report reviews broadband performance in major cities in Ireland and aims to convey the findings from both customer and technical perspectives, producing a ranking for the best performing Internet Service Providers in the area. Insight into the likely performance levels of popular broadband uses such as web surfing, Voice over Internet Protocol (VoIP), internet gaming and streaming video were the drivers behind the technical aspects measured. Performance measurements were conducted using a network of satellite devices and software agents that connect to the internet and perform automated test routines. The dataset used for this report was based on over 5 million tests.

The data was first qualified with attention to unusual findings of metrics that were then individually analysed and vetted for accuracy. To determine the overall rankings a proprietary algorithm was utilised to subjectively weigh a wide range of metrics that affect customer experience.

The Key Performance Indicators used for the index were:

- 'Up To' Comparisons / TCP[9] Throughput Speed
- HTTP[10] Download Speed
- Traffic Management
- Ping performance
- DNS[11] Lookup Time
- Packet Loss performance

European City Preliminary Internet Performance Index

The Epitiro, European City Preliminary Internet Performance Index (2008) preliminary report provides an insight into broadband performance in major European cities from both customer and technical perspectives. The cities included in this preliminary report include Amsterdam, Dublin, Lisbon, London, Paris, Madrid, Milan and Zurich. Insight into the likely performance levels of popular uses such as web surfing, VoIP, internet gaming and streaming video were the drivers behind the technical aspects measured.

The methodology used is the same as that in the Ireland Internet Performance Index, however, the results of this study compares broadband quality between cities rather than ISPs.

The report concludes that there is a significant 'digital divide' amongst European cities in terms of broadband performance. Whilst all cities and ISPs can handle basic web browsing and email, the demands of VoIP and streaming media may not be reliably met by ISPs in some cities tested.

[9] Transmission Control Protocol - the protocol used by major Internet applications such as the World Wide Web, email, remote administration and file transfer.
[10] Hypertext Transfer Protocol - an application protocol for distributed, collaborative, hypermedia information systems and the foundation of data communication for the World Wide Web.
[11] Domain Name System - a hierarchical distributed naming system for computers, services, or any resource connected to the Internet or other private network.

A Global Study of Broadband Quality

Using nearly eight million records from actual broadband speed tests conducted by users around the world using www.speedtest.net, the Oxford Said Business School (2008) study calculated statistical averages of several key performance parameters used to determine the quality of a broadband connection for 42 countries. The team concluded that broadband experience is mainly affected by broadband speeds, both upstream and downstream, latency, network oversubscription and packet loss. These parameters were grouped into three major categories: download and upload throughput, and latency.

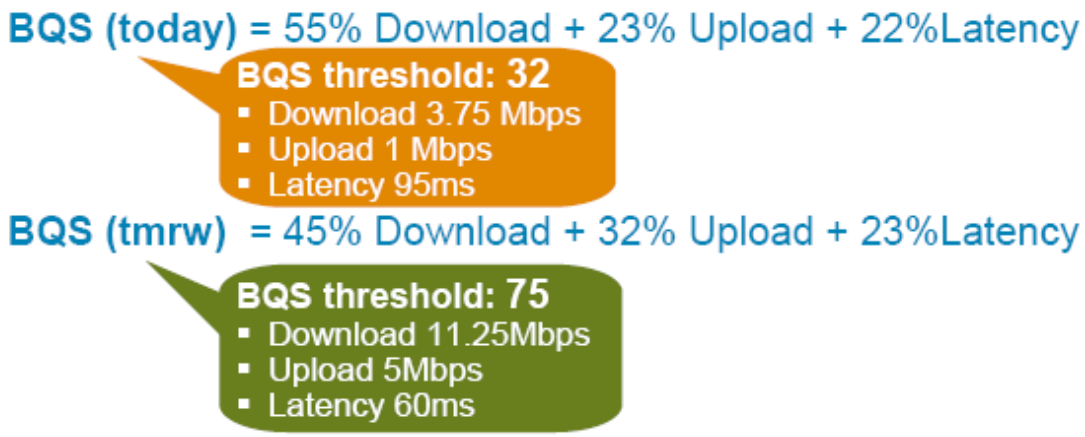


Figure 6.6 – Broadband Quality Score calculation, University of Oviedo; Delphi interviews; Oxford University Team Analysis, August 2008

The Broadband Quality Score (BQS) was determined using a formula that weighted each category according to the quality requirements of a set of popular applications now, BQS (today), and in the future, BQS (tomorrow), as seen in Figure 6.6. Typical applications for today include web browsing, social networking, music downloads, basic video streaming and video chatting, standard definition Internet Protocol Television (IPTV), and enterprise-class home offices. Future applications that will require increased quality in broadband, i.e. increased download and upload speeds and reduced latency, include consumer tele-presence for communications, healthcare and education, high-quality video file sharing and streaming, high-definition IPTV, cinema-quality live event broadcasts and advanced home automation.

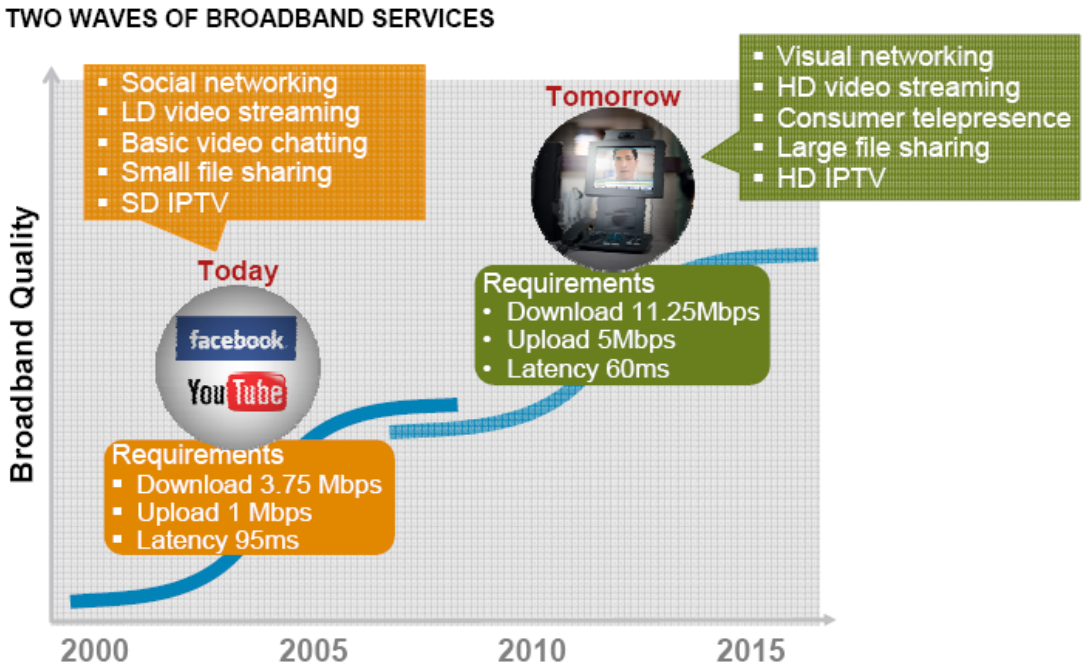


Figure 6.7 – Changing quality requirements of broadband services, California Broadband Task Force, January 2008; Cisco IBSG; Expert interviews; Oxford Team Analysis August 2008

The study concluded that, whilst many countries have a BQS that is sufficient to meet today's requirements, Japan is the only country within the 42 studied that achieved a BQS that matches future requirements as depicted in Figure 6.7.

Having reviewed these examples of broadband performance measurement, the following sub-section will now consider the most appropriate index method for this study.

6.6.2 Selection of Index method

Most broadband performance indices thus far have concentrated upon the requirements of home users. However, due to having different requirements and being important to the economy, it is vital that the needs of businesses are also taken into account when considering policy and regulatory developments. In Ireland for example, Forfas (2007) states that the key issue from an enterprise development perspective is the limited range and speed of broadband services available rather than coverage in itself.

A broadband index helps to compare broadband development in different areas, highlighting areas of weakness, so that policy making can target the real problems. Now that the debate on broadband

has moved from coverage to quality, the most appropriate indicators to use as performance indicators of the broadband market are service quality, competition and take-up of advanced services.

The examples studied have concentrated upon the quality of broadband at a country level and for comparing the performance of Internet Service Providers (ISPs). This study will use an index to either compare the quality of broadband between two regions or between individual businesses.

Collecting data from key indicators in a similar way to the Ireland Internet Performance Index and by taking into consideration other factors, such as competition, an index score for each local authority area could be calculated to compare the provision between the two.

However, a more suitable index for the thesis would be to create an index for comparing individual businesses. A Broadband Quality Score similar to that used in the Oxford example but using a weighting specific to that of business requirements rather than home users would provide an input for the broadband model seen in Figure 6.2. By comparing businesses using the matched-pair methodology this index score could provide the variable between the businesses that would show whether there is a correlation between broadband quality and economic impact on a business. Such an index could be very useful in illustrating elements that are not immediately apparent from a mere analysis of coverage and penetration rates.

Furthermore, such an index would also be able to compare the economic impact of high quality broadband between similar businesses within each area of the research as well as between the two areas which will help to highlight whether broadband quality is the true factor for any difference rather than other factors.

Having chosen the index method, the following sub-section will now consider the key indicators that the index will comprise of.

6.6.3 Selection of Sub-Indicators

Table 6.1 provides a list of possible sub-indicators which may influence the value of broadband services, and can therefore be used in a broadband index measurement.

Indicator	Components	Description	Rationale	Issues	Positives
Coverage	Coverage of all premises	% of premises connected to a local exchange that provides a broadband service	This is a measure of the geographical digital divide.	Coverage is likely to be 99% + in all Welsh LAs	
Price	Price of broadband services > 2Mbps	Difference in cost of the cheapest available service offering 'up to' 2Mbps	A comparison of prices to broadband access	Prices are similar throughout Wales thanks to Ofcom	Cable and LLU may make some difference, particularly when comparing urban and rural areas
	Price of broadband services < 2Mbps	Difference in cost of the cheapest available service offering more than 2Mbps			
Competition	Alternative infrastructure	A measure of the number of different infrastructures offering broadband services in the area, DSL, Cable, 3G Mobile	This is a measure of the level of competition. Stronger platform competition is assumed to lead to more innovation, investment and choice. Platform competition translates into high penetration rates when broadband coverage is generalised.	There is very little alternative infrastructure in Ceredigion	
	LLU	Total number of LLU lines as a % of all lines connected to a local exchange		There is very little LLU in Ceredigion	

Indicator	Components	Description	Rationale	Issues	Positives
Quality	Upload Speed	Average speed of tests using isposure software	High-speed broadband lines are required to deliver advanced services such as IPTV. Speeds provide a proxy for the quality of a broadband service.	Will require downloading a piece of software as part of the questionnaire	Very useful for measuring the difference of broadband quality between two SMEs or two areas.
	Download Speed	Average speed of tests using isposure software			
	Latency	Average speed of tests using isposure software	Many advanced applications require low latency in order to function correctly		
Headline Advertised Download Speeds	Coverage of premises	% of premises by availability of providers' headline speed offerings	This is a measure of the highest available download speeds in an area	Doesn't give an indication of real speeds achieved	
Take-up of broadband	Take-up of broadband by SMEs	% of SMEs subscribing to a broadband service		Almost all SMEs have some sort of broadband service so little difference	
Take-up of advanced services (i.e. advanced online business applications and services)	eCommerce	% of enterprises with an online store % of enterprises accepting online payments	Measure of the propensity of enterprises to use advanced services	Provides a very good indicator of use of advanced services and therefore the requirements of high quality broadband. (The greater the sophistication of services used the higher the quality requirement)	Indicates levels of media literacy and willingness to participate in new services as well as the ability to participate due to high quality broadband
	eInvoicing	% of enterprises sending electronic invoices			
	eGovernment	% of enterprises filling in official forms online			
	eBanking	% of SMEs who use online banking			

Indicator	Components	Description	Rationale	Issues	Positives
Socio-economic	eSkills		A measure of the skills necessary to fully utilise a broadband service		Indicates levels of media literacy and willingness to participate in new services as well as the ability to participate due to high quality broadband
	ICT expenditure or investment		A measure of investment made by SMEs in ICT as a percentage of turnover		

Table 6.1 – Summary of possible sub-indicators

6.6.4 Sub-Indicator Summary

Here we summarise the indicators in order to establish which indicators should be used in the final index measurement.

Coverage - Coverage of basic broadband access is near 100% in both areas and any difference will be difficult to measure. The broadband debate has moved from coverage to quality and, consequently, the coverage of basic broadband is no longer an important indicator when considering future policy.

Price – Due to regulation, there are no regional differences in the costs of basic broadband services within the UK. Differences are encountered in the costs of enhanced services and in high bandwidth services, however, most SMEs would not require such services and, as such, differences in pricing would likely be negligible over a large sample. Furthermore, any difference in pricing will be due to the availability of alternative infrastructure and, consequently, any difference in the pricing indicator would mirror that of the competition indicator.

Competition –Competition has a significant effect on the type and quality of services available in an area and can also have an effect on cost. Due to the heavy investment of competitors in highly populated areas and the very low levels of investment in rural areas, there is likely to be a great difference in competition between the two areas of research. However, most rural areas will have no competition whatsoever. As such, comparing an area with no competition to an area with vast competition may be unsuitable.

Quality – Due to the nature of DSL technologies, the download and upload speeds, and therefore the quality of a service varies significantly with the distance of a premise from its local telephone exchange. As such, there is likely to be a significant difference in the average speed achieved by SMEs between the two areas. This difference can impact the types of applications and services that can be used which, in turn, will impact on the economic effect that a broadband service can have on an SME. The speed of each SME's broadband service can be measured using online testing software, creating a Broadband Quality Score (BQS) which combines actual download and upload throughput, and latency, with different weights matching current, and future, application requirements.

Headline advertised download speeds – Whilst there is often a difference between the headline advertised speeds available between different areas, headline advertised download speeds do not give an accurate indication of the actual speeds achieved in area. Henceforth, a measure of real speeds achieved would be a far more appropriate indicator.

Take-up of broadband – Take-up of broadband in SMEs is likely to be near 100% for both areas. Consequently, there will be little difference as an indicator.

Take-up of advanced services – Many advanced services require increased levels of quality in order to function correctly. However, this would provide a measure of media literacy within businesses as much as an indication of the quality of broadband available to the business.

Socio-economic – These indicators are an important aspect of the impact of broadband on a small business since a higher level of skill and ability in using broadband related services and applications is likely to result in higher economic impact. However, this is not a measure of the quality of broadband access in itself and, as such, is not an appropriate indicator for this index. The issues of skills and ability will however be studied further during the SME questionnaire and the subsequent case studies.

Having considered the possible sub-indicators for the broadband index, the most suitable indicators to use for this study are measures of quality for the broadband service.

As such, the broadband index for this study will measure a score based upon the download speed, upload speed and latency of the broadband services received by SMEs for differentiating the quality of service provided. These will be measured using software freely available on the Internet.

Since the values for each indicator are measured on differing scales, they will need to be standardised/normalised to a notionally common scale in order to create an index score. The following sub-section will set out the method used for standardising all indicator values.

6.6.5 Standardisation of Sub-Indicators

For each individual indicator, the average across all indicator scores and the standard deviation are calculated. The normalisation formula (OECD,2008) is:

$$X_{i,\,-1\text{ to }1} = \frac{X_i - \left(\frac{X_{Max} - X_{Min}}{2}\right)}{\left(\frac{X_{Max} - X_{Min}}{2}\right)}$$

Where:

X_i = Each data point i

X_{Min} = The minima among all the data points

X_{Max} = The maxima among all the data points

$X_{i,\,-1\text{ to }1}$ = The data point i normalized between 0 and 1

This results in all indicator scores having similar dispersion and, consequently, are comparable and can be used in an index. However, all indicators do not affect broadband performance equally and, consequently, must be weighted to reflect the varying impact of each indicator upon the overall index score. The following sub-section will consider which method to use for weighting these indicators.

6.6.6 Weighting

The three indicators chosen for the index, download speed, upload speed and latency, all have varying importance to the broadband needs of SMEs. As such, it is important to reflect this variance in importance in each indicator in terms of their relative importance within the index. Weighting involves emphasising the contribution of some aspects of a data set to a final result, giving them more weight in the analysis. Therefore, rather than each variable in the data contributing equally to the final result, some of the indicators will be adjusted to contribute more than the others.

The method chosen for this weighting is the Budget Allocation Process (BAP) (OECD,2008). In the BAP, a purposive sampling method is applied to identify experts on a given theme described by a set of indicators. These subject experts are then asked to allocate a "budget" of one hundred points to the indicator set, based on their experience and subjective judgment of the relative importance of the respective indicators. The weights are then calculated as average budgets. The main advantages of BAP are that it's a transparent and relatively straightforward process and can be completed in a relatively short period of time. It is essential that experts representing a wide spectrum of knowledge and experience are brought together to ensure that a proper weighting system is established. This process requires that special care be taken in the identification of the population of experts from which to draw a sample and it is crucial that the selected experts are not specialists for individual indicators, but rather for the given sub-index. For example, a biodiversity index should be handled by biodiversity experts, not by ornithology experts.

Advantages of the BAP:

- Weighting is based on expert opinion and not on technical manipulations.
- Expert opinion is likely to increase the legitimacy of the composite and to create a forum of discussion in which to form a consensus for policy action.

Disadvantages of the BAP:

- Weighting reliability. Weights could reflect specific local conditions (e.g. in environmental problems), so expert weighting may not be transferable from one area to another.
- Allocating a certain budget over a too large number of indicators may lead to serious cognitive stress for the experts, as it implies circular thinking. The method is likely to produce inconsistencies for a number of indicators higher than 10.

- Weighting may not measure the importance of each individual indicator but rather the urgency or need for political intervention in the dimension of the individual indicator concerned (e.g. more weight on Ozone emissions if the expert feels that not enough has been done to tackle them).

The budget allocation process has four different phases:

- Selection of experts for the valuation;
- Allocation of budgets to the individual indicators;
- Calculation of weights;
- Iteration of the budget allocation until convergence is reached (optional).

The Delphi technique has been described as 'a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem' (Linstone & Turoff)

It is used to establish as objectively as possible a consensus on a complex problem, in circumstances where accurate information does not exist or is impossible to obtain economically, or inputs to conventional decision making for example by a committee meeting face to face are so subjective that they risk drowning out individuals' critical judgments – clear evidence of broadband quality requirements for the future does not exist so this is the best way of obtaining the best possible prediction i.e. getting consensus from a panel of experts who have the knowledge of applications and services that are under development and the quality levels they will require.

The basic method as described by Delbecq et al is:

1. develop initial questionnaire (Appendix C) and distribute it to the panel
2. panellists independently generate their ideas in answer to the questionnaire and return it (Appendix D)
3. the moderator summarizes the responses to the first questionnaire and develops a feedback report along with the second set of questionnaires for the panellists
4. having received the feedback report, panellists independently evaluate earlier responses and independently vote on the second questionnaire (Appendix E)

5. the moderator develops a final summary and feedback report to the group and decision makers

Variations of this basic technique include

- The number of iterations (the more rounds, the closer the consensus likely to be reached)
- The method of selection and size of the panel: anything from five or six to several hundred participants
- The scoring system and the rules used to aggregate the judgements of the panellists
- The extent of anonymity afforded to the panellists
- How consensus is defined and how disagreements are dealt with

6.7 Case Study Methodology

Case study research is widely perceived as being high quality when in-depth analysis is required and can be particularly useful when a new field or subject is being explored where not many statistics on the subject presently exist. The major strength of case study research methods are that data can be collated from a variety of sources that are both quantitative and qualitative (Yin, 1989).

The case study method:

- is a rigorous methodology that allows decision-making processes and causality to be studied;
- is ideal for studying topics where existing theory is inadequate;
- allows SMEs to be studied from multiple perspectives rather than under the influence of a single variable;
- allows a more thorough examination of each SME than a narrowly-defined quantitative study, through multiple data collection methods, thus allowing the researcher to become knowledgeable about each SME so that new insights on the subject can emerge;
- allows issues of cross-industry biases, small sample size and resistance to survey methods to be avoided.

As discussed in section 6.3, during this research project, the case study method will be used to further investigate issues raised by the questionnaire survey analysis and to add detailed qualitative data to the quantitative data collected in the survey. The analysis of the questionnaire results, as well as the analysis of the BQS and EIS derived from the questionnaire, will highlight issues, trends,

expected/unexpected results which will form the basis for discussion during the case studies in order to form a greater understanding of the analysis and to provide evidence to explain the nature of the results. The analysis of the questionnaire results will also help identify the most suitable businesses for selection during the case studies in order to explain the issues raised. The analysis of the study will be supported by the evidence provided by these case studies.

6.8 Conclusion

This chapter has explained the mixed methods approach undertaken for this research study, giving reasons for the methods used supported by a literature review of previous related studies. This included a review of previous technology related indices, explaining the selection of indicators for the index within this study, how they were standardised and how the weighting for each indicator was derived. The chapter has also developed a model to measure whether the way that varying quality of broadband would affect the economic impact upon SMEs. This lead on to an explanation of the derivation of the questionnaire from this model and how it will be used to inform the issues that will be further investigated through case study research. A methodology for these case studies was also provided.

Chapter 7 – Analysis of the research

7.1 Introduction

This chapter describes the results of the SME survey and provides an analysis, based on the methodology developed in the previous chapter, of the results for the Cardiff and Ceredigion areas. In the chapter, we also report the results of the experts' questionnaire and the Broadband Index Score formula resulting from this, as well as the results of the Economic Impact Scores derived from the SME survey.

The chapter concludes with an analysis of whether a relationship exists between the BIS and the EIS of the SMEs involved in the research and the conclusions that can be drawn from these results, supported with evidence from interviews undertaken with some of the SMEs who took part in the original SME survey. Additionally, thoughts on improving the research methodology to provide a more accurate assessment of these scores, particularly in relation to planned roll-out of superfast broadband, are provided.

7.2 SME Questionnaire Graph Analysis

The SME survey questionnaire (Appendix B) was sent via email to one hundred SMEs in each of the two research areas. Nineteen SMEs in each area completed the survey from a variety of industry sectors, as seen in Table 7.1. Despite the small sample, the businesses cover a broad range of industry sectors. The graphs relating to the analysis of the responses can be viewed in Appendix F. The relationship between the tables in this chapter, the questions they relate to in the SME questionnaire (Appendix B) and the figures in Appendix F are listed in Appendix G.

Ceredigion	Cardiff
Removals and storage	Audio-visual
Tourism	Financial services
Food	Publishing
Environmental consultancy	Graphic design consultancy
Electronics	Water
Computer services	Hospitality
Distribution and wholesale	Automotive
Pharmaceutical automation	Graphic design
IT	Printing and promotional goods
Print and publishing	Travel
IT	IT
IT /web development	Pharmacy/medical
Graphic design	Construction
Architecture	Architecture
Film and video production	Chartered surveyors
Electronics	Industrial leisure
Travel	Television production
Entertainment	Television post production
Tourism	Agriculture

Table 7.1 – Industry sector breakdown of surveyed SMEs

Company size	Cardiff	Ceredigion
1 person	1	6
2 – 10	13	11
11 – 50	3	2
50+	2	0
Average number of employees	20.0	6.7

Table 7.2 – Company size of surveyed SMEs

The average number of employees was higher in the surveyed SMEs from Cardiff than in Ceredigion and almost a third of the Ceredigion companies were single traders compared to just one in Cardiff, as seen in Table 7.2. This could have some impact on the results with smaller companies having fewer resources to spend on maximising the impact of their broadband connection.

7.2.1 The Broadband Connection

	Cardiff	Ceredigion
No broadband connection	0	0
Mobile device	0	0
ADSL/DSL (i.e. via a telephone line)	13	14
Cable modem	2	1
Leased line	0	0
Wireless broadband	4	4
Satellite broadband	0	0
Don't know/Other	0	0

Table 7.3 – Type of broadband connection used by surveyed SMEs

Most of the surveyed SMEs access their broadband via ADSL/DSL based services, as shown in Table 7.3. However, 8 companies claim to receive Wireless broadband. Considering the very small number of wireless broadband connections there are in Wales, as discussed in Chapter 4, it is highly likely that these are in fact ADSL/DSL services that have a wireless WiFi local network rather than wireless broadband services. These results suggest that there is a lack of knowledge and technical understanding of broadband within these SMEs.

7.2.1.1 Download and Upload Speeds

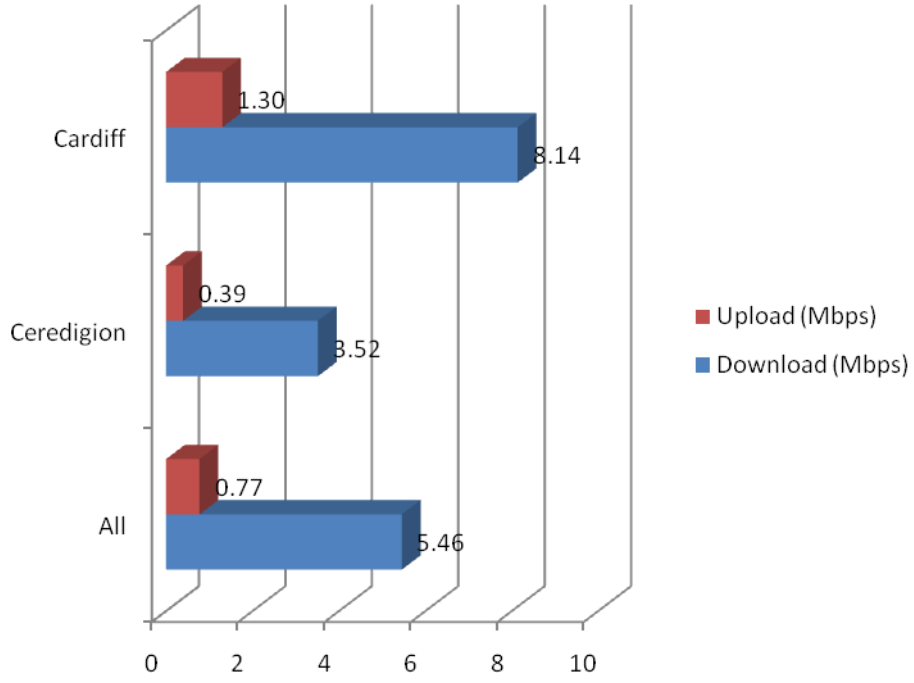


Figure 7.1 – Average download and upload speeds

Average download and upload speeds, in Cardiff, as seen in Figure 7.1, are more than double those in Ceredigion, reflecting the longer last mile distances in rural areas and the lower availability of ADSL2+ and fibre-based products. This is a significant difference in service speed provision between the two areas.

7.2.1.2 Quality of Service

Many of the packet loss tests failed and the vast majority of those that did not returned a 0% packet loss result and, as such, there is very little differentiation to analyse. This parameter has already been disregarded for the index and these results justify that decision.

The average for the ping test for Cardiff SMEs was 53ms compared to 48ms in Ceredigion which suggests that latency is better in Ceredigion. However, these results were skewed by an abnormal result and, as such, the median values represent a truer picture of the difference with the median value in Cardiff at 36ms compared to 45ms in Ceredigion. Whilst this difference is not great, it further strengthens the case that broadband quality in Ceredigion is inferior to that in Cardiff.

The jitter parameter has also been disregarded for the purposes of the index as it is a measurement of the variance in ping tests and is less significant than the ping test itself. Again, the average results for jitter were skewed by the abnormal result, although this time the median score for Cardiff was higher at 6ms than in Ceredigion at 4ms. Whilst this shows that the jitter is worse in Cardiff than in Ceredigion, a difference of 2ms compared to 9ms in the ping test, still indicates that overall latency is worse in Ceredigion than in Cardiff.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Ability to accept online payments	4 (2,2)	10 (6,4)	22 (11,11)	1 (0,1)	1 (0,1)
Ability to undertake research	15 (8,7)	16 (9,7)	6 (2,4)	1 (0,1)	0 (0,0)
Access to online services and applications	17 (9,8)	19 (9,10)	2 (1,1)	0 (0,0)	0 (0,0)
Ability to source and purchase supplies online	16 (9,7)	22 (10,12)	0 (0,0)	0 (0,0)	0 (0,0)
Communication with customers	18 (11,7)	18 (7,11)	2 (1,1)	0 (0,0)	0 (0,0)
Ability to use online training tools	10 (2,8)	15 (8,7)	12 (8,4)	1 (1,0)	0 (0,0)
Ability to market to a wider marketplace	14 (9,5)	19 (6,13)	5 (4,1)	0 (0,0)	0 (0,0)
Efficiency of marketing	11 (7,4)	20 (10,10)	7 (2,5)	0 (0,0)	0 (0,0)
Ability to transfer large files quickly	12 (9,3)	14 (5,9)	4 (2,2)	7 (2,5)	1 (1,0)
Other	2 (0,2)	2 (1,1)	32 (18,14)	2 (0,2)	0 (0,0)

Table 7.4 – Importance of business functions (figures in brackets represent the Ceredigion/Cardiff split in the replies)

Table 7.4 indicates that the most important functions of broadband are to enable research to be undertaken, source and purchase supplies online, communicate with customers, and market to a wider marketplace. A less important function was the ability to accept online payments, although this was nevertheless used by a significant number of SMEs and will probably grow in popularity as confidence in electronic trading increases (see Appendix F, Figures F.2 – F.10).

	Use	Choose not to use	Don't use due to an inferior quality broadband connection
Website	32 (15,17)	5 (4,1)	1 (0,1)
Online store/shop provision	10 (7,3)	27 (12,15)	1 (0,1)
Receiving online payments	12 (9,3)	25 (10,15)	1 (0,1)
CRM (Customer Relationship Management)	8 (4,4)	29 (15,14)	1 (0,1)
SCM (Supply Chain Management)	5 (2,3)	32 (17,15)	1 (0,1)
Video Conferencing	5 (2,3)	24 (14,10)	9 (3,6)
VoIP	14 (9,5)	17 (7,10)	7 (3,4)
Online Banking	34 (15,19)	4 (4,0)	0 (0,0)
Google Applications	29 (13,16)	9 (6,3)	0 (0,0)
eBay (or other online auction site)	28 (14,14)	10 (5,5)	0 (0,0)
Other applications employed	8 (3,5)	30 (16,14)	0 (0,0)

Table 7.5 – Applications and services (figures in brackets represent the Ceredigion/Cardiff split in the replies)

Use of basic applications are high in both areas, however, use of more advanced services, such as SCM and video conferencing, are higher in Cardiff, as shown in Table 7.5. Two interesting points to arise from the results shown in Table 7.5 are that far more SMEs in Ceredigion use VoIP than in Cardiff, whilst many Cardiff SMEs are reporting that their connection does not have sufficient quality to support video conferencing (Figures F.11 – F.21).

Only around one in ten surveyed SMEs use video conferencing. However, as shown in Table 7.6, more than twice as many do not use it due to an inferior broadband connection. Upload speeds are more important for video conferencing than most applications as the data must travel to and from the premises. As such, this may indicate that the download speeds received by businesses are adequate but that their upload speeds are not. Almost twice as many SMEs in Cardiff reported an inferior connection than in Ceredigion showing evidence for the requirement of better quality connections in Cardiff as well as Ceredigion. Meanwhile, considerably more SMEs in Ceredigion use VoIP than in Cardiff. Almost one in five SMEs claim not to use VoIP due to an inferior broadband

connection, with more of these coming from the Cardiff area. Again, due to the two-way nature of voice communications, upload speeds are more important for VoIP and this may indicate that the download speeds received by businesses are adequate but that their upload speeds are not. VoIP is often used as a free/cheap means to communicate with people abroad and the significantly higher usage in Ceredigion could mean that rural SMEs are broadening their market further than urban SMEs who already have enough customers within their local area.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Cost savings	16 (8,8)	14 (8,6)	5 (2,3)	3 (1,2)	0 (0,0)
Time savings	22 (12,10)	14 (6,8)	1 (1,0)	1 (0,1)	0 (0,0)
Increased customer satisfaction	16 (9,7)	12 (7,5)	9 (3,6)	1 (0,1)	0 (0,0)
Improved product design	7 (2,5)	10 (7,3)	19 (10,9)	2 (0,2)	0 (0,0)
Higher customer retention	12 (7,5)	7 (4,3)	17 (8,9)	2 (0,2)	0 (0,0)
New business opportunities	12 (7,5)	14 (7,7)	11 (5,6)	1 (0,1)	0 (0,0)
More efficient internal operations	13 (6,7)	14 (6,8)	10 (7,3)	1 (0,1)	0 (0,0)
Higher skilled workforce	3 (0,3)	13 (6,7)	17 (11,6)	4 (1,3)	1 (1,0)
None	0 (0,0)	1 (1,0)	26 (14,12)	6 (1,5)	5 (3,2)
Other	1 (0,1)	3 (1,2)	33 (18,15)	1 (0,1)	0 (0,0)

Table 7.6 – Impacts (figures in brackets represent the Ceredigion/Cardiff split in the replies)

The majority of SMEs surveyed, as shown in Table 7.6, agreed that broadband had resulted in cost savings for their business, while almost all SMEs surveyed agreed that broadband had resulted in time savings for their business. Meanwhile, more than four in five SMEs in Ceredigion agreed that broadband had resulted in increased customer satisfaction compared to around three in five SMEs in Cardiff. This could be due to the improved communications with customers through broadband. Also, around half of the surveyed SMEs reported that broadband had resulted in higher customer retention. More SMEs in Ceredigion agree that broadband has resulted in higher customer retention than in Cardiff. This is likely due to the improved customer satisfaction resulting from broadband.

Almost seven in ten SMEs reported that their productivity has improved due to broadband with slightly more positive results in Ceredigion, reflecting the higher scores for benefits such as time savings (Figures F.22 – F.31).

Almost seven in ten SMEs reported that broadband had provided them with new business opportunities, as shown in Table 7.7. SMEs from Ceredigion were more positive about this than in Cardiff, possibly resulting from the increased ability of marketing to a wider marketplace. Indeed, almost seven in ten surveyed SMEs in the Ceredigion area agreed that broadband had increased their target marketplace compared to around half in Cardiff. One in ten SMEs in each area disagreed. Furthermore, more than half of all SMEs surveyed strongly agreed or agreed that turnover had increased due to broadband, supporting the results of increased new business opportunies through broadband.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Cost savings	15 (8,7)	20 (10,10)	2 (1,1)	1 (0,1)	0 (0,0)
Time savings	17 (10,7)	18 (8,10)	2 (1,1)	1 (0,1)	0 (0,0)
Increased customer satisfaction	15 (9,6)	18 (7,11)	3 (3,0)	2 (0,2)	0 (0,0)
Improved product design	11 (6,5)	9 (4,5)	16 (9,7)	2 (0,2)	0 (0,0)
Higher customer retention	13 (8,5)	13 (5,8)	10 (6,4)	2 (0,2)	0 (0,0)
New business opportunities	13 (8,5)	17 (7,10)	7 (4,3)	1 (0,1)	0 (0,0)
More efficient internal operations	12 (6,6)	16 (7,9)	9 (6,3)	1 (0,1)	0 (0,0)
Higher skilled workforce	8 (2,6)	9 (6,3)	18 (10,8)	3 (1,2)	0 (0,0)
None	1 (0,1)	3 (0,3)	26 (18,16)	5 (1,4)	3 (1,2)
Other	0 (0,0)	3 (1,2)	34 (18,16)	1 (0,1)	0 (0,0)

Table 7.7 – Future impacts (figures in brackets represent the Ceredigion/Cardiff split in the replies)

Ceredigion SMEs are consistently more positive about the benefits of broadband on their business than their Cardiff counterparts. This is particularly evident with regards to customer retention and customer satisfaction. However, Cardiff SMEs were more positive about the benefits to a higher skilled workforce and internal operations. Table 7.7 shows that more than half of all SMEs surveyed

reported that profit had increased due to broadband. Whilst the number of businesses in each area who strongly agreed and agreed collectively was similar, twice as many SMEs in Ceredigion than in Cardiff strongly agreed (Figures F.32 – F.41).

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Productivity	17 (10,7)	9 (4,5)	9 (3,6)	3 (2,1)	0 (0,0)
Turnover	12 (7,5)	9 (3,6)	11 (6,5)	5 (2,3)	1 (1,0)
Profit	9 (6,3)	12 (5,7)	11 (5,6)	5 (2,3)	1 (1,0)
Target marketplace	11 (6,5)	12 (7,5)	11 (4,7)	4 (2,2)	0 (0,0)
Number of employees	2 (1,1)	4 (3,1)	21 (10,11)	10 (4,6)	1 (1,0)

Table 7.8 – Increases due to broadband access (figures in brackets represent the Ceredigion/Cardiff split in the replies)

Table 7.8 shows that only around three in twenty SMEs reported an increase in the number of employees due to broadband. Many of the SMEs surveyed were micro businesses with a very small workforce which are likely to require more impact to their business than broadband alone can provide in order to require more employees. Twice as many surveyed SMEs in the Ceredigion area as in Cardiff strongly agreed or agreed that broadband had resulted in an increase in their number of employees, reflecting higher scores for impact such as increasing new business opportunities (Figures F.42 – F.46).

	Continuing	First year only	No gain
Productivity	25 (13,12)	4 (2,2)	9 (4,5)
Turnover	22 (10,12)	3 (1,2)	13 (8,5)
Profit	21 (10,11)	2 (1,1)	15 (8,7)
Target marketplace	24 (12,12)	3 (1,2)	11 (6,5)
Number of employees	9 (7,2)	2 (1,1)	27 (11,16)

Table 7.9 – Continuing increases from broadband (figures in brackets represent the Ceredigion/Cardiff split in the replies)

When questioned about the possibilities of continuing increases of benefits, the majority of respondents indicated that productivity, turnover, profit and target marketplace would increase over a longer term than just the first year, as seen in Table 7.9. A much smaller number indicated any expected growth in jobs, as was to be expected given the small size of the companies involved (Figures F.47 – F.51).

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
How strongly do you agree/disagree that the quality/reliability of your existing broadband service is satisfactory?	4 (1,3)	19 (11,8)	3 (0,3)	9 (5,4)	3 (2,1)
How strongly do you agree/disagree that your business could continue to operate efficiently without broadband access?	0 (0,0)	1 (1,0)	1 (0,1)	11 (5,6)	25 (13,12)
How strongly do you agree/disagree that your business could operate better with an improved broadband connection?	20 (10,10)	11 (6,5)	5 (3,2)	2 (0,2)	0 (0,0)

Table 7.10 – The broadband connection (figures in brackets represent the Ceredigion/Cardiff split in the replies)

Table 7.10 refers to questions 8, 15 and 16 in the SME questionnaire (Appendix B) and the results are also shown in Figures F.1, F.53 and F.54. Most of the businesses indicated satisfaction with the quality and reliability of their existing broadband service, although around a third indicated that it is not satisfactory. Only a small proportion (4 out of 38) indicated strong satisfaction with their existing broadband connection suggesting that most businesses are aware that that improvements to their connections could be made.

The majority of businesses agree that their business could not continue to operate efficiently without a broadband connection, and the majority also agree that an improved broadband connection would improve their business operations.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Download speed	20 (10,10)	14 (8,6)	2 (1,1)	2 (0,2)	0 (0,0)
Upload speed	25 (13,12)	9 (5,4)	2 (1,1)	2 (0,2)	0 (0,0)
Reliability	25 (13,12)	9 (5,4)	2 (1,1)	2 (0,2)	0 (0,0)

Table 7.11 – Broadband connection components (figures in brackets represent the Ceredigion/Cardiff split in the replies)

Table 7.11 refers to question 17 (Figures F.55 – F.58) about improvements in broadband connection components in relation to future business requirements. Improvements in both download and upload speeds, as well as improvement in service reliability, are requirements shared by the majority of the businesses.

7.3 Broadband Index Score and Economic Impact Score Analysis

In order to try to measure the differing impact that varying quality of broadband services has upon SMEs, the development of the broadband index requires weighting the quality aspects of a broadband service in terms of their importance.

The process used for this is the Budget Allocation Process (BAP) (OECD,2008), where experts on a given theme (e.g. innovation, education, health, biodiversity, …) described by a set of indicators are asked to allocate a "budget" in percentage terms to the indicator set, based on their experience and subjective judgment of the relative importance of the respective indicators. Weights are calculated as average budgets. The main advantages of BAP are its transparent and relatively straightforward nature and short duration. It is essential to bring together experts representing a wide spectrum of knowledge and experience to ensure that a proper weighting system is established.

In order to do this a number of subject experts undertook a brief two-part questionnaire in order to create this weighting. As well as SMEs, consumers were also included in this exercise in order to show the differing needs of SMEs compared to consumers regarding their broadband services.

Eleven experts took part in the study (a summary of their profiles can be viewed in Appendix I) and, taking into consideration the applications and services used by, respectively, SMEs and consumers,

over their broadband connection, both currently and in the foreseeable future, were asked to indicate the importance they believed should be assigned to the three individual quality indicators; download speed, upload speed and latency, in percentage terms. All were also asked to explain their thinking behind their answers in a comment box.

	SMEs				**Consumers**		
Download	**Upload**	**Latency**			**Download**	**Upload**	**Latency**
50	35	15			60	25	15
40	40	20			50	30	20
30	50	20			55	25	20
45	35	20			70	20	10
35	45	20			50	30	20
42	33	25			51	28	21
50	30	20			55	25	20
45	30	25			45	35	20
43	29	28			58	26	16
45	30	25			60	25	15
50	30	20			55	25	20
43.18	**35.18**	**21.64**			**55.36**	**26.73**	**17.91**

Table 7.12 – Results from the first round from the expert panel

Some experts were keen to point out that broadband as a complete service is more important for SMEs than for consumers and may therefore require better quality in all three parameters. However, the purpose of this study is to discern the relative importance of each individual parameter comparatively.

Expert 1 - "For SMEs, the overall importance of having good quality broadband connection is in fact much more important than for consumers (possibly by a factor of 2 or 3), so it is slightly misleading to find some of the percentages lower in the SME column. Nevertheless – the balance of factors is what you are looking for".

The results from the first round questionnaire, as shown in Table 7.12, clearly indicate that download speed is the most important parameter of broadband quality for both groups.

Expert 4 - "*For both SME and Consumer, historically, volumes of data being downloaded have exceeded the upload quantities, a fact reflected in the directional imbalance of ADSL. Download is clearly something that is happening far more frequently than uploading and so of far more general importance".*

However, the experts are also clear that, for small businesses, the other two parameters have greater significance than for consumers.

Expert 1 - "For the consumer, the greatest volumes of transactions will be incoming rather than outgoing, most consumers, whether shopping, downloading entertainment, or just browsing, will be receiving for more data than they are generating - most of which will be fairly large files – film, video, photographs, all capacity-hungry. The average consumer will not be generating many very large files, so download outweighs upload by a considerable margin".

Expert 3 - "For the SME, the 3 factors you have asked about have roughly equal importance".

Expert 2 - "SMEs would require a more balanced download and upload connection and latency would not be so much of an issue. It is difficult to judge how much "convergence" will take place with the broadband connection being utilized for all business services including VOIP and then latency would be more of an issue".

Expert 6 - "SMEs will be more likely than consumers to carry out high volumes of uploading, for instance updating their websites, sending out customer information, marketing communications, organizing delivery agents etc. In this environment latency will be very important, both in communications with their suppliers and with customers – the latter may get irritated with slow response times, and abort their transactions, resulting in lost business".

This reflects the difference in usage of broadband by the two groups with SMEs uploading more data and using more real-time, two-way communications than consumers whose usage revolves mainly around downloading data.

Expert 2 - "Some SMEs will be producers of content and will need high upload speeds. For example graphic designers and photographers will need to share their work with their collaborators. All producers of content will need high upload capacity to distribute their products".

Expert 8 - "The SMEs that might be particularly affected by high latency are those using some form of online conferencing or meeting – especially if they use it to demonstrate their products".

Expert 7 - "SMEs certainly require greater upload speeds than your average consumer so a better balance between upload and download speeds would better satisfy their needs".'

These first round results were averaged and each participant was sent their individual answers and the average answers to compare, as well as the comments made by all participants, and asked to reconsider their answers based on this information. All answers and comments were presented anonymously.

	SMEs				**Consumers**		
Download	**Upload**	**Latency**			**Download**	**Upload**	**Latency**
45	40	15			60	25	15
40	40	20			50	30	20
30	45	25			55	25	20
35	35	30			65	20	15
35	45	20			55	25	20
42	33	25			51	28	21
50	30	20			55	25	20
45	30	25			50	30	20
43	31	26			58	26	16
40	30	30			60	25	15
45	35	20			55	25	20
40.91	**35.82**	**23.27**			**55.82**	**25.82**	**18.36**

Table 7.13 – Second round questionnaire results from expert panel

The changes in the second round questionnaire were very small, as seen in Table 7.13, with download speed importance dropping from 43% to 41% being the greatest change. It was therefore considered that a third round would be unlikely to make any further significant changes and the

second round results are considered to be final. These measurements were rounded to the nearest whole percentage point and produce a final Index formula:

Broadband Index Score = 41% (Download speed) +36% (Upload speed) – 23% (Latency)

Download and upload speeds are both given positive signs as the higher their value the better the quality of the broadband service, whilst latency is given a negative sign since the quality of service improves as latency lessens.

7.3.1 Correlation between BIS and EIS

The results of the study, as shown in Figure 7.2, indicate that there is currently no simple relationship between economic impact and the quality of broadband service within SMEs. In part this is due to the relatively small variation in values for the BIS when contrasted with a much larger variation in the EIS for individual SMEs, although there was a little more variation in BIS for SMEs in Cardiff than in Ceredigion.

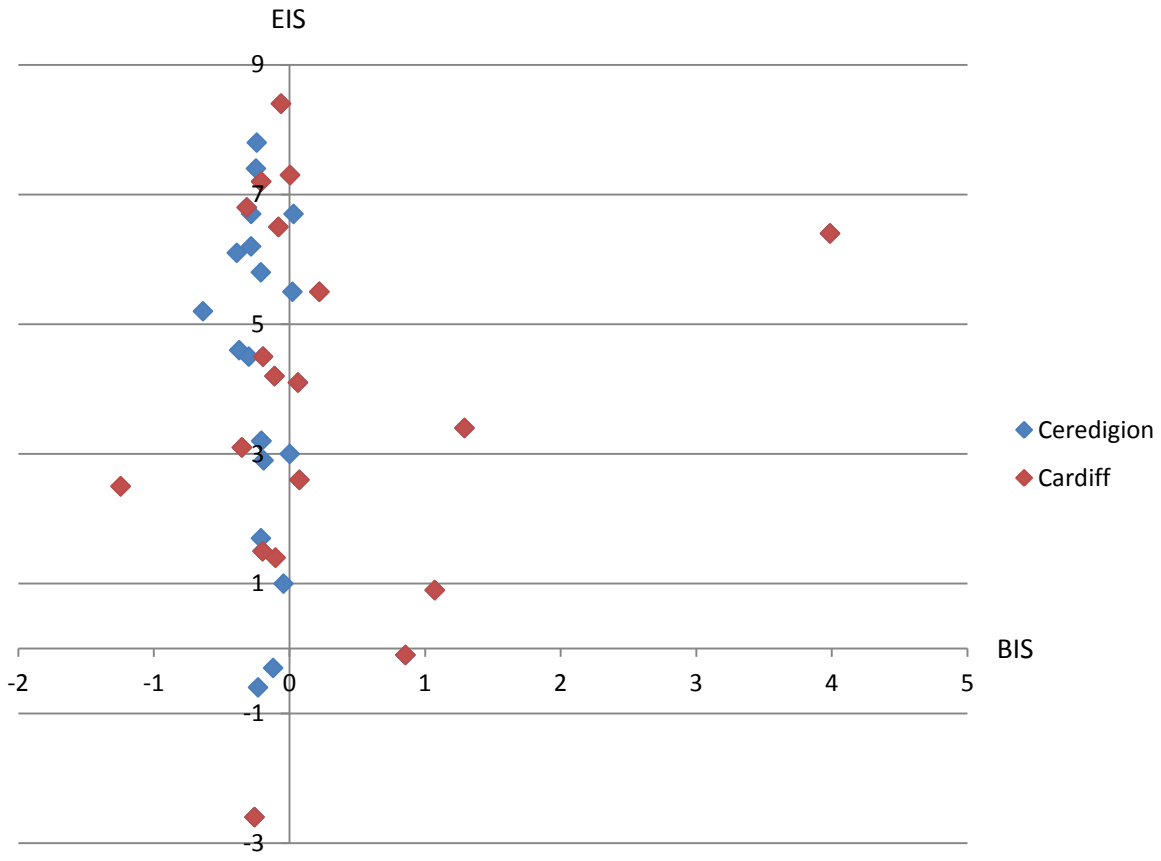


Figure 7.2 – Plot of Economic Impact Score versus Broadband Index Score

However, this does not necessarily indicate that broadband access in itself has not had an economic impact on SMEs as all but one of the participating businesses had a positive economic impact score. This is further strengthened by the fact that 36 of the 38 participating businesses disagreed that their business could continue to operate efficiently without broadband access as seen in Figure 7.3.

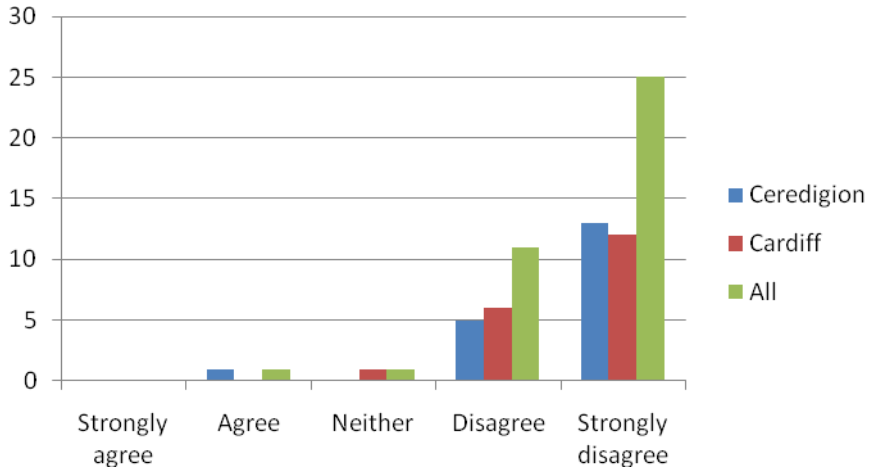


Figure 7.3 – Answers to the question: How strongly do you agree/disagree that your business could continue to operate efficiently without broadband access?

There may be many reasons why a relationship between broadband service quality and economic impact has not materialised. One reason could be that SMEs do not currently have the required skills and knowledge to understand and utilize the applications and services that can be used with a higher quality broadband service. However, as seen in Table 7.14, the majority of participating businesses believe that they do have the skills and knowledge, suggesting that this is not the case. Despite these results, whilst businesses believe they have the skills and knowledge required, this may not in fact be the case, and many businesses may not be aware of the more complex or sophisticated services available to them. This issue will be further investigated in the case studies.

Another reason could be that many SMEs do not have any requirement for the more sophisticated applications and services than can be used over a higher quality service and, as such, a basic service fulfils their requirements. In this case, any improvement in the quality of service delivered would not result in an improvement in economic impact.

7.3.2 Analysis of Extremes

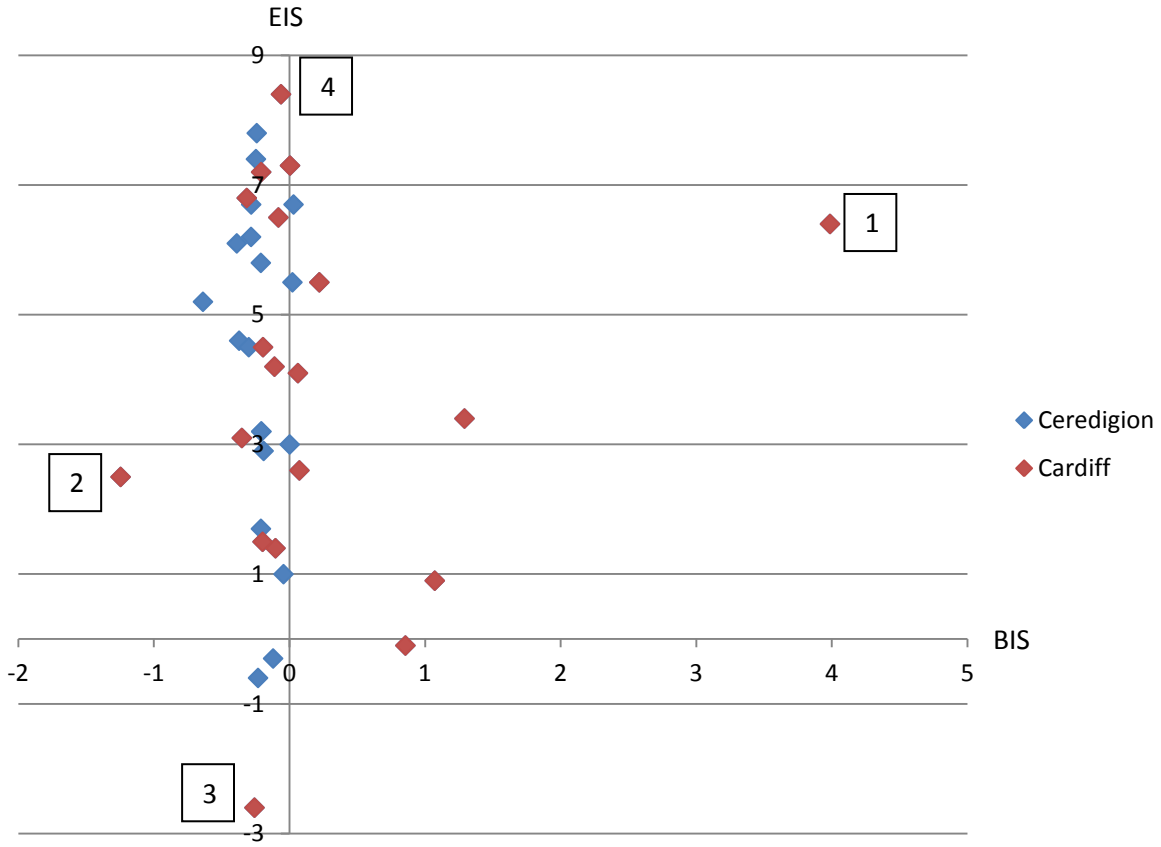


Figure 7.4 – Plot of Economic Impact Score versus Broadband Index Score highlighting the 4 extreme cases

The SME reporting the highest broadband score, as indicated by [1] in Figure 7.4, also has one of the highest economic impact scores. The very high Broadband Index Score is due to having a fibre optic based service that offers considerably higher download and upload speeds than the copper based services used by the other businesses in the study. The owner of this business commented that: "I've clicked disagree in the boxes immediately above this (How strongly do you agree/disagree that improvements in the following components of your broadband connection; download speed, upload speed and reliability, will be important for your business in the future?) – "as my broadband is so fast and so good (I have BT infinity) I don't see how making it any faster would improve things. If only all businesses had access to this sort of broadband!" Most of the economic impact marks that were lost were through 'neither agree nor disagree' answers to questions regarding improved product design and higher skilled workforce. Since this business is a service providing sole trader, this may explain the neutral answers in these sections.

The SME reporting the lowest broadband score, as indicated by [2] in Figure 7.4, has a below average economic impact score of 9 and also had average scores for two of the broadband index components but an extremely poor score for the latency component. This reading is likely to be very unreliable as it is highly unlikely that the latency of the broadband connection would be so poor for more than a short period of time.

The SME reporting the lowest economic impact score, as indicated by [3] in Figure 7.4, has a below average broadband quality score. This business highlighted two applications/services that they did not use due to an inferior quality broadband connection which may again indicate an issue with inconsistency and/or reliability that has not been captured by the one-off measurement. The owner also answered 'disagree' when asked whether the business possesses the skills and knowledge to fully utilize the broadband connection, suggesting that the economic impact score may be low due to the business' inability to exploit the potential offered by broadband access rather than a lack of quality broadband service.

The SME reporting the highest economic impact score, as indicated by [4] in Figure 7.4, has an above average broadband quality score. This business also highlighted two applications/services that they did not use due to an inferior quality broadband connection which may again indicate an issue with inconsistency and/or reliability that has not been captured by the one-off measurement. However, in this case, it does not appear to have negatively affected the business' perception of the economic impact of their broadband connection. The business 'agrees' that it has the skills and knowledge to fully utilize its broadband connection which may to some degree explain the high economic impact of the broadband connection.

7.3.3 Industry Sector Analysis

In order to compare similar businesses, a cluster analysis (as discussed in section 5.3), is undertaken of businesses within the same industry sector cluster. The two industry sector clusters that are apparent from the survey sample are the three television production businesses, as highlighted in Figure 7.5, and five IT businesses, as highlighted in Figure 7.6.

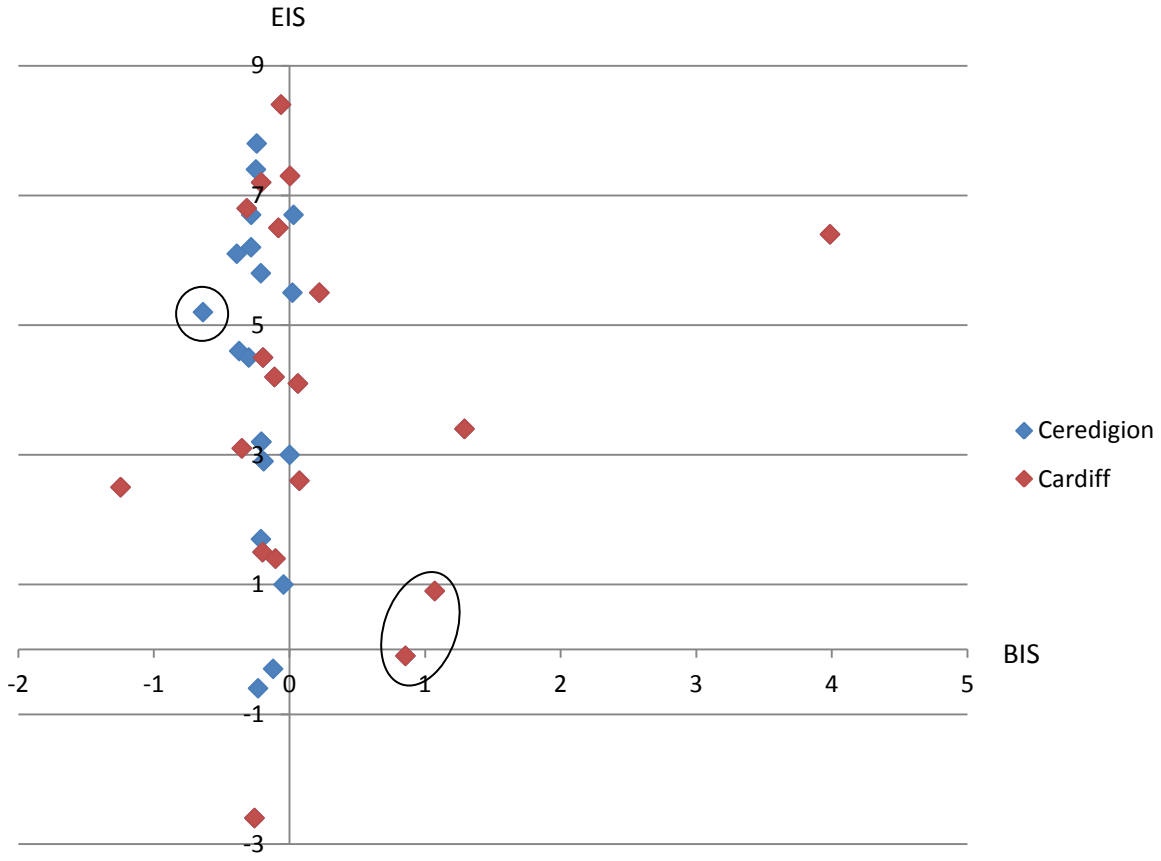


Figure 7.5 – Plot of Economic Impact Score versus Broadband Index Score highlighting businesses from the Television Production Industry

The cluster highlighted in Figure 7.5 includes the third and fourth highest Broadband Index Scores in the study, yet the Economic Impact Scores for these businesses are not particularly high. The cluster includes two businesses working in television production within Cardiff, which have a requirement for very high quality broadband. Despite having a high quality service compared to the other participant businesses, this score may still represent a low quality service in comparison to their requirements, and hence, has resulted in a relatively low economic impact score. However, the other business highlighted in Figure 7.5 is a television production company based in Ceredigion. This business has the second lowest BIS but a relatively high EIS. This could possibly reflect a difference in

perception due to the length of time that broadband has been available in each area. Broadband was available in Cardiff considerably earlier than in Ceredigion and media businesses are likely to have been early adopters of such technology. As such, the Cardiff based businesses would have experienced some economic impact from broadband years ago but are now aware that they could achieve greater impact with an improved service, whereas in Ceredigion, businesses may have upgraded to broadband from dial-up far more recently and have achieved an economic impact from this upgrade more recently and are, consequently more positive about this outcome at present.

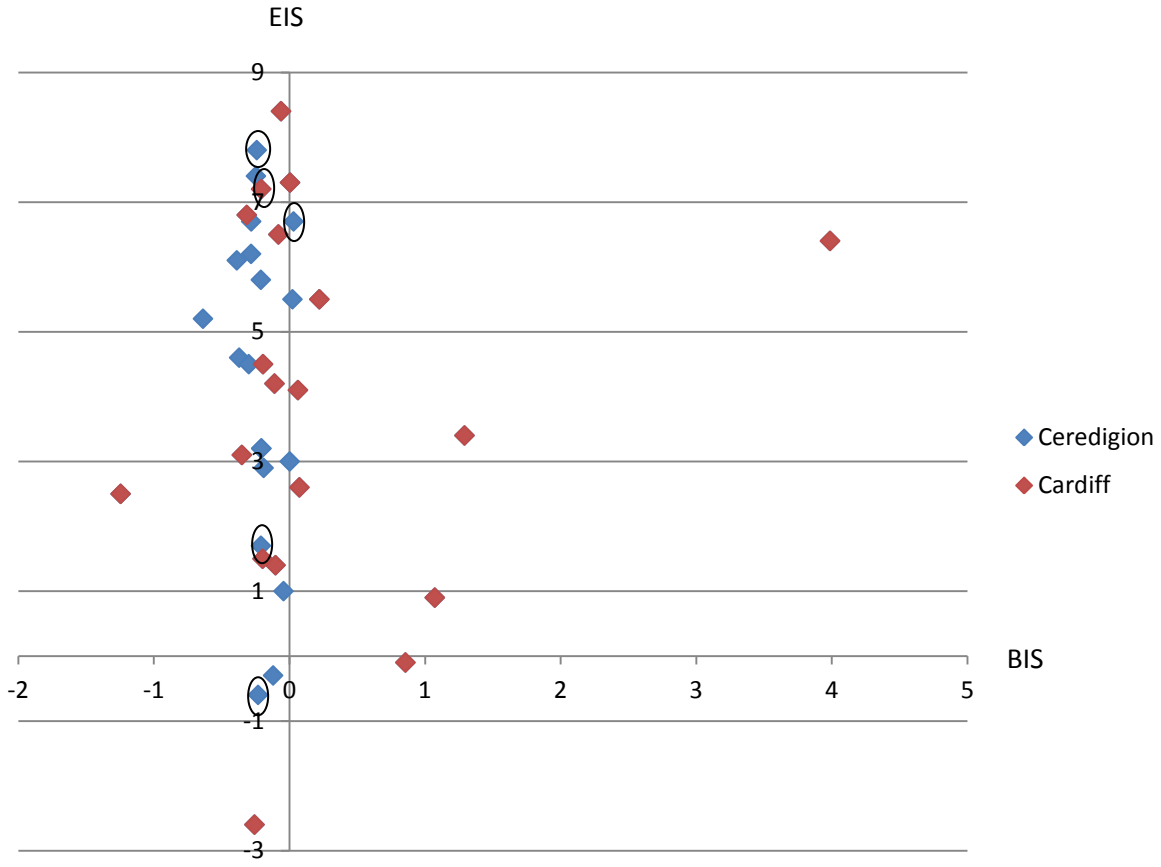


Figure 7.6 – Plot of Economic Impact Score versus Broadband Index Score highlighting businesses within the IT industry

Figure 7.6 highlights the businesses which work within the IT industry. All five of these businesses had average broadband index scores, however there is a significant variance in their economic impact scores. As would be expected, some of the IT businesses were within the highest scorers for economic impact overall with three of them achieving marks of +6.7 or greater. However, the other two IT businesses scored some of the lowest overall economic impact scores of just +1.7 and -0.6. Both of these businesses answered that they are unable to use a service or application due to having an inferior broadband connection whilst only one of the other three answered in the same way,

indicating that their broadband connection was too inferior to be able to run a website, although they do in actual fact have a website – it is possible that this was an inaccurate answer or that they run their website from another location/through a third party in order to overcome this issue and hence its impact is not reflected in their economic impact score. The fact that all five businesses have similar broadband index scores, yet some are indicating that their connection is inferior for running some applications or services whilst others are not, indicates that a one off measurement of the broadband service is failing to highlight other issues such as inconsistency in service levels and/or reliability of the service. An approach using measurements over a period of time may be considered to counter this issue.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
How strongly do you agree/disagree that your business possesses the skills and knowledge to fully utilise your broadband connection?	9	20	5	4	0

Table 7.14 – Answer to: How strongly do you agree/disagree that your business possesses the skills and knowledge to fully utilise your broadband connection?

	Disagree	Neither agree nor disagree	Agree	Strongly agree
All	14.8 (4)	12.4 (5)	15.4 (20)	17.2 (9)
Cardiff	13.3 (3)	7.0 (2)	14.8 (12)	22.5 (2)
Ceredigion	19 (1)	12.7 (3)	16.3 (8)	15.7 (7)

Table 7.15 – Average EIS for answer to the question; 'How strongly do you agree/disagree that your business possesses the skills and knowledge to fully utilise your broadband connection?' (Numbers in brackets indicate the number of responses for each answer)

Table 7.15 shows the average EIS of surveyed SMEs in relation to the answer given to the question: 'How strongly do you agree/disagree that your business possesses the skills and knowledge to fully utilize your broadband connection?' There is a general, though not universal, trend indicating that the more strongly SMEs believe that they have the required skills and knowledge to fully utilize their broadband connection, the higher their EIS score is. This strengthens the assertion that, currently, skills and knowledge in utilizing broadband currently has a greater impact upon the ability of SMEs to profit from their broadband connection than the quality of the connection itself. Since there are other factors influencing businesses' ability to derive a positive economic impact from the use of a

broadband connection, some businesses will still achieve a high EIS score despite believing that they do not have the necessary skills and knowledge to fully utilize their connection, such as the one business in Ceredigion to answer 'disagree' to the question yet scored a high score of 19. Such anomalies may be reduced if a survey with a higher number of respondents were undertaken which may lead to a more reliable trend.

The trend could be yet more distinct if the skills and knowledge were assessed by an independent source rather than by the businesses themselves as the case studies indicate that some businesses are not as skilled as their answer in the original survey suggests. For example, Company A answered that they neither agreed nor disagreed that they possessed the skills and knowledge to fully utilize their broadband connection, however, from the case study interview it became apparent that their skills and knowledge were in fact very inadequate and an answer of 'disagree', or even 'strongly disagree' would have been more appropriate. This would, in turn, have created a more distinct trend in Table 7.15 due to their very low EIS score of -7. This further strengthens the notion that a qualitative methodology, such as the use of case studies, would produce more reliable and better findings than a quantitative methodology based upon survey data and individuals' perceptions, and that some businesses not only believe that their skills and knowledge are lacking, but in fact have such poor awareness of the potential impacts that broadband could provide, have even lower skills and knowledge than they themselves recognise.

It is also indicated by Table 7.15 that more businesses replied 'strongly agree' in Ceredigion (7) than in Cardiff (2) however the EIS scores for the Ceredigion respondents are lower. This could be due to the over-estimation of the skills and knowledge that they posses and that poor awareness of the potential provided by a broadband connection has resulted in businesses that are highly skilled in limited applications of broadband without realising the limitations of their knowledge. It could be argued that this is partly due to broadband being available to businesses in Cardiff for longer than their counterparts in Ceredigion so that they have become more aware of limitations in skills as their experience has increased. However, there may be other causes for this phenomenon that should be further researched, such as poorer delivery of awareness and skills programmers or less collaboration between businesses in rural areas than in urban regions, or more localised areas, which could lead to a better understanding of how to maximise the economic potential offered to SMEs by broadband.

Figure F.29 (Appendix F) shows that more than half the SMEs surveyed in Cardiff reported that broadband had resulted in a higher skilled workforce compared to only three in ten SMEs in Ceredigion, reflecting the greater use of online training tools in Cardiff and possibly their greater experience of broadband applications.

7.4 Case Studies

7.4.1 Introduction to Case Studies

Three case studies were undertaken with businesses in each of the Cardiff and Ceredigion areas to further investigate the effect of broadband quality on their businesses and to investigate whether they consider that they have sufficient skills and knowledge to fully exploit online trading.

Due to the small sample of replies to the questionnaire and only a proportion of these being willing to undertake a follow-on case study interview, seventeen out of the total sample of 38, it was not possible to select matched pairs of businesses for direct comparison. Consequently, the sample of businesses chosen for the case studies was based purely upon the issues raised from the survey questionnaire.

Having analysed the data from the questionnaire, the following issues were highlighted as starting points for further discussion with the six businesses taking part in the case study interviews:

Importance of broadband:

- How important broadband is to the business and why;
- whether the quality of the broadband connection has ever restricted the business from fully exploiting the possibilities offered by broadband and whether there are any applications/services that they would like to use but are unable to due to the quality of the broadband connection;
- improvements in which components of the broadband service would the business most like to see; download speed, upload speed or reliability and why.

Benefits of broadband:

- Cost and time savings identified due to broadband and whether these cost savings cover the cost of the broadband connection;
- how broadband has impacted upon turnover and profitability and whether broadband has resulted in an increase in employees or whether it is likely to in the future.

Marketing and communication:

- Whether the business has an online marketing strategy;
- whether the business' target marketplace has increased due to broadband and how the geographical location of customers has changed due to broadband;
- who does the business contact using VoIP and how important VoIP is to the business;
- whether the business uses social media applications such as Blogs, Twitter, Facebook, etc., for marketing purposes and why or why not;
- whether broadband has allowed the business to improve customer retention and allowed it to increase customer satisfaction.

Skills and knowledge:

- Whether the business possesses the necessary skills/knowledge to fully exploit broadband;
- Whether the business is fully aware of the broadband services and applications that could be utilised and whether they keep up to date with developments in these fields;
- Whether the business have the skills/confidence to use advanced applications and services such as CRM, SCM, video conferencing, etc.

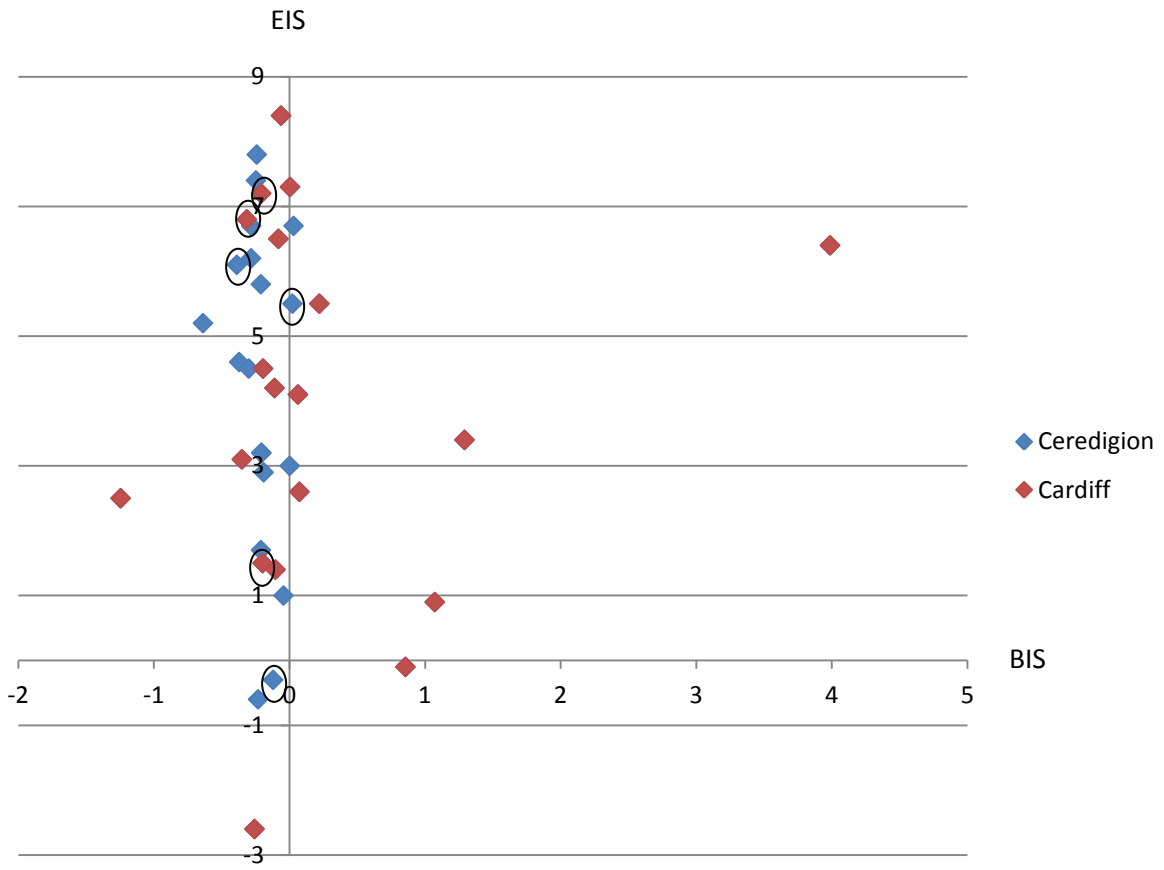


Figure 7.7 - Plot of Economic Impact Score versus Broadband Index Score highlighting the case study businesses

7.4.2 Business A

Industry Sector: Tourism

Number of employees: 2

Broadband Index Score: -0.1206

Economic Impact Score: -0.3

Business A is a small live music and conference venue on the outskirts of a small village in rural Ceredigion. It was one of the few businesses to record a negative Economic Impact Score despite having one of the highest Broadband Index Scores in Ceredigion and answering 'neither agree nor disagree' to whether they felt they had the necessary skills and knowledge to fully utilise their broadband. As such, it was selected in order to investigate why its EIS was so low. It is also located in a very rural area and is in one of the most important industry sectors to its region.

Business A believes that they do not make enough use of the internet and, despite answering 'neither agree nor disagree' in the questionnaire, upon reflection consider that they do not have the

necessary skills or knowledge to fully utilize the benefits of broadband. Furthermore, they also lack confidence in their ability to utilize their broadband service. They do not consider themselves to be aware of the potential benefits offered by broadband and believe there is a definite need to make more use of the broadband connection in order for the business to progress.

They have never been offered any help by the Welsh Government but have received help from Antur Teifi, a social enterprise that provides specialist business advice and support, in terms of online marketing, although contact with them has now been lost due to their contact there leaving the job. The company feel that the Welsh Government are letting SMEs down in their failure to help but also SMEs need to take a share of the blame for not asking for more help.

Their broadband connection is used every day for email and web access and is so vital that they believe the business would not survive without it. It has been particularly helpful in attracting customers through the website and they are heavy reliant on email.

They consider their connection to be slow but they have become used to it and, as their use is unsophisticated, they do not feel a great need for a faster connection. However, they have had trouble downloading large files in the past and when media/TV companies have used the WiFi offered in the conference centre it has crashed due to being unable to handle so many users. They also believe that another issue is that their customers also have slow broadband and, consequently, they struggle to be able to use the website.

Time savings for Business A include; using email rather than a phone, which allows them to reply when convenient and is quicker and easier - no wasting time with long conversations, and getting quotes for purchases and services.

The main cost savings come from having a greater choice of suppliers. These are savings that they consider to be much greater than the cost of the broadband connection itself and these alone justify the cost of a broadband service.

Customer retention and satisfaction has increased through better communication via email and through the website. However, they consider it difficult to be able to attribute any increase in turnover or profit to broadband as these have decreased in recent times due to the economic climate. There has been no increase in staff due to broadband but there are only 2 full time

employees so there would need to be a very significant increase in workload to increase staff numbers by even one.

Business A has no marketing strategy and understands that they have had a lack of foresight where marketing is concerned. They have no money to spend on marketing and, consequently, they are very interested in undertaking marketing through social media as it is free to use. The company already distributes email newsletters, utilizes yell.com, and Google have been in contact with them regarding Search Engine Optimisation but, presently, they cannot afford it. They would like to build upon this but do not know how to use social networking sites. They would very much like to be able to use Facebook and Twitter in particular because this would improve their marketing with their younger target audience. The company considers social media to be the way forward for them in terms of marketing and believe it would be a *"big help"* but are unsure how to go about utilizing it. In terms of other applications and services, the business' awareness of what is available is very low. One of the few other services they are aware of is Skype, but they do not use and claim to have little knowledge of it.

The business has worries about people abusing their online presence following an episode when some people set up a non-existent event for a University at the venue and are, as such, concerned that their lack of skills and knowledge makes them vulnerable in terms of online security.
One of the main issues to worry the company recently is a high turnover in staff. They consider that their rural location plays a big part in this and that there is nothing in the area to attract people to stay.

Although the company agrees that broadband has allowed them to broaden the geographical base of their marketplace, local people are still their main customers. However, the company did provide an example of an event which was located at the venue that would not have taken place without broadband access as it came about purely by them being contacted through the website by an artist from the USA.

In terms of other telecommunications issues, the company believes that they lose customers due to poor mobile reception in the immediate vicinity. More and more people are asking about what the mobile reception is like when making enquiries. The venue recently hosted a singing contest where the audience voted via text and it was a great disappointment that many could not get a signal.

However, they are hopeful that this situation may improve in the near future as they believe that a new mobile mast is being placed in the area soon.

In conclusion, whilst the quality of broadband access is an issue for the company, location is the biggest impairment to success. This was recently summed up by a customer who described the venue as; *"Fantastic venue but it's in the wrong place".*

7.4.3 Business B

Industry Sector: Tourism

Number of employees: 3

Broadband Index Score: -0.3886

Economic Impact Score: 6.1

Business B provides holiday accommodation in a remote area of Ceredigion. It scored a high EIS of 6.1 despite having a low BIS score. As such, it was selected in order to investigate why its EIS was so high and to establish the importance of broadband to a business in such a remote location.

Broadband is considered to be absolutely vital to Business B as all of their customers come through the internet so the business would not survive without it. "*Broadband has made our business possible. Without it we wouldn't be able to do what we do. In fact, we don't know what we'd be doing without it".*

The business start date was put back by a year purely because they were unable to get a broadband connection. However, their broadband connection is now so good that *"we could be in the middle of the city"*. They regularly use high bandwidth applications such as iplayer and have experienced no problems with reliability.

However, whilst they themselves have had no problems with their broadband service, others in the vicinity have not been so lucky. None of the neighbours have a good connection and next door is so poor that they really struggle even with email.

Cost savings experienced by Company B include; allowing the business to manage their own website which is cheaper; comparing prices for goods and services online; and getting specialist supplies via

the internet rather than having to travel long distances to specialist suppliers. These savings are *"definitely"* greater than the cost of a connection.

The business has a wide target marketplace due to broadband. The business has customers from Saudi Arabia, Belgium, and other countries, which they believe would be highly unlikely if they did not have the ability to *"communicate with people from other countries via email and Skype"*. Broadband access also allows them to research internationally, e.g. seeing what similar businesses in Australia are offering.

The business believes that broadband has had a huge impact on profit and turnover and believes that broadband has a greater impact on rural areas than urban areas.

In terms of applications and services, Skype is very important for communicating with customers as it saves costs, especially for calling abroad. It is also used to keep in touch with family in NZ and Holland as well as with customers. They now use the phone much less due to Skype.

Company B use Facebook, Youtube, and have just started using Twitter. They also have a blog on the website. Facebook does not bring in new custom but by keeping people up to date with news from the farm it leads to repeat bookings as it *"gives people a feeling of being connected to the farm all year round"*. Most new bookings come via Google searches. They have been offered courses for using Twitter and for using the internet to improve business etc., but have not attended any as they believe they are very computer literate.

They believe they have good knowledge and skills for making the most of their connection. The person in charge of IT has a degree in vehicle design and consequently has good IT skills, particularly design software which is useful for the website. Their broadband service allows them to control the website themselves rather than communicating their ideas through someone else, which keeps costs down and gives them greater control over the end product. The website is updated every week or two and needs to be real-time for booking availability. As such, a reliable broadband service is essential and any down time could lead to missed bookings and, henceforth, financial loss.

In terms of mobile reception, the business location receives fair mobile coverage but mobile signal is lost occasionally. They believe that it is possible that they may have lost a few bookings through not having a signal but it is not likely to be many.

The business has significant competition, both home and abroad, and it is important that they return people's enquiries as quickly as possible, which broadband allows them to do; *"If you don't reply to people within about 2 hours, often people will have looked elsewhere".*

The current economic climate has not had a detrimental effect on the business and they believe that it may even have helped. Many of their customers have told them *"we didn't go abroad this year as it's too expensive".*

Antur Teifi and Medrwyn [local business support units] were very helpful and gave good advice, particularly with the business plan and marketing "allows us to be connected to everything without being in a city". "Privileged to live in this area".

7.4.4 Business C

Industry Sector: Publishing

Number of employees: 24

Broadband Index Score: 0.022

Economic Impact Score: 5.5

Business C is a publishing company set in a small rural town that also has a sister office in the larger town of Carmarthen. Consequently, its semi-rural location differs from the more rural locations of the other case study businesses chosen from Ceredigion and it scored one of the highest BIS scores in Ceredigion and a fairly high EIS of 5.5. It is also the largest of the case study businesses, employing 24 people.

Business C believe that broadband is "vitally important to the business" and an "excellent tool". They have a sister office in Carmarthen which is constantly linked to the MIS system so need a very reliable broadband connection so that the system is always in sync between both offices. So much work is done on the system that if the link crashes many man hours of work are lost which can cost thousands of pounds. The broadband link crashes quite often.

The business is located on a new site so do not understand why they could not be given fibre at the building stage. It seemed logical so cannot understand why this did not happen. They have managed to get BT to place a new connection because the original was so bad but still had to settle for copper.

“If you want business to succeed in rural areas then investment in fibre would attract businesses to these areas”. There’s a definite need for investment for fast broadband. “Lack of joined up thinking from stakeholders”. They believe that government should be pushing for better and faster broadband for rural Wales. The possibilities offered by broadband to businesses are invaluable. “Money spent wisely on broadband would produce major improvements in productivity and cost savings for rural businesses”.

Company C believes that it does not have sufficient knowledge to make the most of what broadband can offer but certainly need it. The company has had no offers of help from WG and has never seen Antur Teifi or similar organization. It thinks that WG sit on the fence and won’t give advice.

They often have to upload and download large files which are a massive time saver but become problematic as the broadband link will crash and they have to start all over again. “The faster the better” but reliability is most important. There is a need for consistency without fallouts
“Things get done faster with broadband and turnover time has shortened, although on the downside people now expect you to get things done quicker”.

They consider that technology is inexpensive for the opportunity it presents. Cost savings far outweigh the cost of a connection.

They consider that they may have increased turnover but it is difficult to be sure, especially as the economic climate has made things very difficult recently. Direct sales have increased thanks to broadband and these have a greater profit margin as there’s no cut for a ‘middle man’. Direct sales would also be likely to increase with eBooks.

“Broadband is the biggest revolution for rural areas – like the advent of the train”
“Broadband will make a big change to us as a business and to rural society in general”
“Broadband is a lifeline to many businesses in rural areas”

They find it difficult to get the right staff in rural areas but believe that “good quality broadband may be one way of keeping the right people in the area”

The business currently does not have an online marketing strategy but certainly concede that they need one, particularly as they consider that their website requires spending a lot of money on in

order to bring it up to date and make it fit for purpose. However, they do not know who to tender for it, especially as it needs to be in Welsh as well as English, and do not know who to turn to for advice on who to tender either. The need to get the website right is considered a particularly important issue, as well as the back office systems link to it, in order to ensure the service provided to end users is good or customers would not return. Meanwhile, the marketing department use both Facebook and Twitter to attract younger customers but are unsure whether they have the necessary skills to fully exploit these marketing mediums. Furthermore, a recent trend the business has become aware of is that the market is moving towards eBooks and, as such, the need for good broadband to support this is becoming greater.

The business doesn't use Skype as they don't have many customers abroad but the interviewee does use it personally and considered its potential use in the future as a good idea for cutting costs when dealing with the few they do.

Customer base has broadened massively due to broadband and the business now has regular customers in Scotland, who they've never met, which wouldn't have happened pre-broadband as all customers pre-broadband were required to meet face to face. Furthermore, 'Silver surfers' have now become a definite target market due to their large spending power, particularly in the current economic climate.

Poor mobile signal was also identified as a big issue in the area for themselves as well as other nearby businesses.

The interviewee also owns a farm in the area and was keen to stress that all paperwork for the farm must now be done online. Every single cow has a passport which has to be applied for online and, consequently, "fast and reliable broadband is essential for the completion of all these forms". He also knows of many farms who have subscribed to expensive satellite connections because they cannot function without broadband and considers this as good evidence that broadband connectivity is as important, if not more so, in rural and remote areas as it is in urban areas.

7.4.5 Business D

Industry Sector: Graphic design

Number of employees: 8

Broadband Index Score: -0.198

Economic Impact Score: 1.5

Business D is a small graphic design business in a suburb of Cardiff. Despite its urban location it did not have a high BIS score and its EIS score was a relatively low 1.5.

Business D believes that broadband is very important to them and that there is no way they would be able to compete with their competitors without it. In fact, without broadband access they believe it would be extremely unlikely that the business could continue to operate productively at all. They are so reliant upon broadband for their communication with customers that on the very few occasions that their broadband service has not been working they have had to either go home to access broadband there, or even use email on their mobile phones whilst in the office.

Business D does not make use of any social media as much of their work is done for the public sector. They therefore generally attract enough work without marketing the company anymore, due to being well established with their existing customers, so do not consider that they have any need for it. They have however undertaken some email marketing and believe that it is much easier to reach the right person in a business through email than it is through postal marketing.

Business D are very satisfied with their current broadband connection and have even turned down the offer of upgrading to a faster service. This is largely due to the fact that the business doesn't require the use of any complex applications and services that require a higher quality connection. The business does however send very large graphic files to their customers, files that are too large for email, but their current service handles this satisfactorily. They do however have occasional instances of customers having trouble downloading these files, partly through poor understanding of the technology and partly through customers' poor broadband connections.

Business D doesn't believe that broadband has directly contributed to any increase in turnover or profit but it has certainly significantly improved their productivity. This has largely been achieved through using email as their main means of communicating with customers so the no longer waste time on the phone.

Broadband has also produced many cost savings for the business as they are able to send graphical images to their customers via broadband whereas previously they had to pay for the use of bicycle couriers. They are also now able to purchase images via online catalogues rather than having to pay

for expensive paper based catalogues. These saving are significantly greater than the cost of broadband subscription.

Despite its low EIS score, it is clear that broadband access is vitally important to Business D. However, due to the fact that the company has a stable customer base and no need to market their services, broadband access has not contributed to any rise in turnover or profit and its impact has mainly been restricted to some improvement in productivity and reduced costs. Consequently, broadband access has not led to a high economic impact in this business.

7.4.6 Business E

Industry Sector: IT

Number of employees: 6

Broadband Index Score: -0.209

Economic Impact Score: 7.2

Business E is a small IT company based in Cardiff. Despite its urban location it does not have very high BIS, but its EIS is a high 7.2. It was selected to investigate the reasons for its high EIS score

Business E believes that they have very high levels of skills and knowledge of IT and believes that they are fully exploiting their current broadband connection.

One of the main issues that business E have encountered in terms of broadband quality is that the quality of their customers connections are sometimes poor and consequently the services that they are able to offer these customers is impacted.

Furthermore, the lack of understanding of broadband based services and applications within their customers also causes issues. They have worked with many SMEs in the South Wales area and believe there is a very real issue with SMEs not fully exploiting the opportunities that broadband provides. Customers are often not using some applications and service that area available to them due to a lack of confidence and knowledge and are therefore not fully exploiting the opportunities available to them. This is a source of great frustration to Business E.

Business E believe that their broadband connection has allowed them to increase profit, turnover and productivity and, without broadband, they would not be able to continue operating their current operations.

7.4.7 Business F

Industry Sector: Industrial Leisure

Number of employees: 4

Broadband Index Score: -0.315

Economic Impact Score: 6.8

Business F is a small business supplying fuel to leisure boats in Cardiff.

Business F indicate that they do not make enough use of the internet and do not have the necessary skills or knowledge to fully utilize the benefits of broadband. Furthermore, they also lack confidence in their ability to utilize their broadband service. They do not consider themselves to be aware of the potential benefits offered by broadband and believe there is a definite need to make more use of the broadband connection in order for the business to progress.

They do not use social media due to a lack of confidence in their skills but would very much like to make use of such applications.

Despite their lack of knowledge, Business F consider broadband to be very important to them as they are regular users of email and the web which have resulted in cost savings from resourcing products and increased productivity.

Whilst broadband has not delivered any gains in profit or turnover, they believe this has much to do with their lack of skills and knowledge and that it is an area they would exploit further in the future.

7.4.8 Case Study Summary

7.4.8.1 Ceredigion SMEs

Business A shows a much lower Economic Impact Score (-0.3) than Business B (6.1) and Business C (5.5) due to the fact that they have been less inclined to aggressively sell products or services online. Business B and C both score better as they have benefited from increased profit/turnover from broadband and have extended their customer base.

The Broadband Index Score shows that both Business A (-0.1206) and C (0.022) score low as they readily acknowledge their frustration at the poor broadband service, whilst Business B scores even lower (-0.3886) but are very satisfied with their service.

Skills and knowledge also varies between the three businesses. Business A and C admit that they do not possess the required skills and knowledge and that they lack confidence in their use of broadband. Business B however, considers that they have good skills and knowledge and are making the most of the opportunities their broadband service presents. This is evidenced by the broader range of applications being utilized by Business B and their confidence in using new social media services.

It is also interesting to note that Business B, who are satisfied with their broadband service and have a high level of skills, score highest of the three businesses in both indices.

7.4.8.2 Cardiff SMEs

Business D shows an EIS figure of 1.5 which is a low value as they do not believe that broadband has directly contributed to any increase in turnover or profit. They also rely heavily on regular public sector customers which reflect their low level of marketing requirements. Their BIS value is an average value of -0.198 as they are very satisfied with their current broadband connection and do not see the need for a higher data speed service. Business E has one of the highest EIS values of all the case study businesses at 7.2 as they have a very high level of skills and knowledge of IT and are maximizing the benefits of their broadband connection. They also have the second highest BIS value of -0.209 as they believe that broadband has allowed them to increase profit, turnover and productivity. This value is slightly negatively affected because they consider that the quality of their customers' broadband service can be poor and that their customers are not sufficiently skilled in

electronic business collaboration. For business F the BIS score is low at -0.315, compared to the other Cardiff case studies. They do nevertheless value their broadband connection which is reflected in a high EIS score of 6.8.

7.5 Conclusion

Whilst there is no evidence to support the theory that economic impact increases as the quality of broadband increases, this study provides much evidence that broadband access in itself does provide an economic impact for SMEs. Almost all SMEs believed that their business would not continue to exist without broadband and the majority believed that they could work better with an improved broadband service.

The theory has been difficult to prove during this research partly due to the fact that there was actually little variation in the quality of the broadband services received by the majority of participants. The BIS, in reflecting broadband quality, had little variation as most SMEs were long standing users of what is now deemed to be an inferior service level compared to 'super-fast' services. Indeed, only one surveyed SME could truly be considered to be using a 'super-fast' service. Consequently, the differences in the EIS scores achieved by most of the participants were influenced less by the BIS and are likely to be attributable to other factors rather than broadband quality alone.

Whilst there is no clear indication that a variance in broadband quality is having an economic impact upon SMEs, the case studies from this research indicate that a barrier to economic gains through broadband use is a lack of skills and knowledge for fully exploiting the potential that broadband access can offer that exists in some SMEs.

Rather than an improvement in quality components such as download speed, upload speed and latency, the issues that currently seem to be having most impact upon SMEs' ability to prosper from broadband access are reliability and consistency of service. However, the majority would still strongly agree that they require improvements in all quality components of their service.
The majority of SMEs currently do not require the use of the more complex and sophisticated applications and services that require higher quality broadband services and, as such, can maximise their economic impact from broadband access with a relatively basic but reliable and consistent service. However, there are niche industries e.g. television production, where higher quality broadband services could result in greater economic impact, hence there remains a case for making higher quality services available to SMEs in Wales.

It is apparent from the case study interviews, that the majority of economic gains resulting from broadband access appear to be achieved from using the basic applications and services such as email, website provision and online store provision rather than more sophisticated services such as

video conferencing. Consequently, in order to evaluate the economic impact created by high quality broadband compared to basic quality broadband a more appropriate approach may be to disregard the basic applications and services from a study and research the impact created by the use of sophisticated services alone. These impacts may seem minor in comparison to those achieved through use of the basic applications and services, but could appear significant when studied alone. Such impacts would result in a higher BIS score and, with resulting beneficial usage of more sophisticated services, would also increase the EIS score. The weighting of the EIS score may also be influenced by the use of more sophisticated tools as these may change the importance of the business functions as highlighted in Figure 6.4. Of particular note are the plans outlined in Chapter 3 of the BDUK in relation to the extension of superfast broadband infrastructure to rural areas of the UK. If this is successful, then a more consistent quality of service level across rural and urban areas, allowing more sophisticated applications to be used by all SMEs, should create a better platform for more meaningful research.

The true barriers that appear to affect economic impact derived from broadband use, such as lack of skills and knowledge, have become more apparent in the case studies rather than from the quantitative data gathered via the questionnaire survey. Consequently, any further research undertaken in this subject area should strongly consider the case study approach when considering a methodology as it provides far greater insight than quantitative methods such as a survey approach.

With broadband being an access technology to a wide range of services and applications, that each in their own right can have an economic impact upon a business, as well as the vast differences of requirements in SMEs from varying industry sectors, it has become apparent during this research that the complexities that arise from this make broadband use in SMEs a difficult subject to gain in-depth knowledge about through quantitative analysis alone. Far greater insight has been achieved through the analysis of case study material and, consequently, any further research in this area should put greater emphasis upon gathering qualitative data, particularly from case studies that allow you to get closer to the issues than any survey methodology.

Two issues that affected this research are that most of the participants had broadband of similar quality, and there was little variance therefore to compare, and that Cardiff businesses have had broadband available to them for longer than Ceredigion businesses and, as such, their perception of how broadband has affected their businesses may be different as those impacts are not as fresh to them and have become more a part of their business routine than for the Ceredigion businesses,

whose experience of these impacts is more recent. Considering these issues and the fact that a case study methodology has proven to give greater insights, a better way of measuring the economic impact of improved broadband quality may be to undertake case studies of businesses which are about to upgrade from basic broadband to a higher quality of service. This would ideally be done with multiple visits to each SME over a period of two years or more to ascertain primarily whether the upgrade in broadband quality has had an economic impact and, secondly, whether such impact was merely short-term or ongoing as the business used broadband services over a period of time.

Alternatively, since a lack of skills and knowledge have been identified in this research as a greater barrier to economic gains through broadband than service quality alone, undertaking case studies of businesses as part of an educational program for improving these skills could measure the economic impact of improved skills and knowledge in utilizing the opportunities afforded by broadband access. Furthermore, a larger study could even combine both elements, since better quality broadband would provide new opportunities for achieving economic gain if SMEs have the knowledge to take advantage of them.

Chapter 8 - Conclusion

8.1 Overview of the study

This thesis has endeavoured to investigate whether varying quality of broadband provision between urban and rural areas of Wales is having a varying economic impact on SMEs in these areas. The starting point for this research was the widely-held perception that broadband access offered SMEs the ability to trade more efficiently and effectively, opened up new markets and provided the opportunity to gain competitive advantages. However, little research had been undertaken to ascertain whether the quality of broadband access has a varying affect upon the degree to which these opportunities can be exploited.

The background of this research was an extensive, on-going literature review plus the author's own experience of working with the Welsh Assembly Government and Welsh Local Government Association (WLGA) on the increasing importance that broadband infrastructure has to play in Wales. Chapter 1 also outlined why this study focused on the quality of broadband provision rather than access alone.

The importance of SMEs to the Welsh economy was outlined in Chapter 2, as well as the importance of ICT to SMEs. The chapter also considered the urban-rural divide in Wales and why investment in communications infrastructure is so important to rural areas.

Chapter 3 focused on the policy importance of broadband within the EU, UK and Wales, looking at targets and strategies of the respective governments and previous interventions undertaken. The chapter also identified the policy justification of government intervention in a number of countries, as resulting from positive economic impact and job creation.

Chapter 4 provided an in-depth analysis of the telecommunications landscape in Wales. This provided evidence for how Wales lags behind the rest of the UK in terms of broadband provision with particular regards to quality of provision. The chapter continued by providing further evidence of the divide in quality of provision within Wales, outlining the difference in quality of provision between urban and rural areas and how this divide will continue to grow in the near future without government intervention, with particular emphasis on the two regions, the local authority areas of Cardiff and Ceredigion, chosen for this study.

A geographic, topographic and demographic profile of the Cardiff and Ceredigion areas was outlined in Chapter 5. This provided evidence of the key differences between the two regions and identified them as the most urban and most rural Local Authority areas of Wales.

The methodology for the study was outlined in Chapter 6, explaining the approach taken. Fundamental to this study was the utilisation of a technology related index, and previous use of such indices and their construction was set out. This review informed the selection of indicators for use in the index developed within this study, how they were standardised and how the weighting for each indicator was derived. Chapter 6 also outlined the ways in which broadband could have an economic impact upon SMEs which led to the development of a model describing how to measure the way that varying quality of broadband would affect the economic impact upon SMEs. An explanation of the derivation of the questionnaire from this model and of the case study methodology utilised were also provided.

Chapter 7 provided an in depth analysis of the research study. This included graphical results of the SME questionnaire and an analysis of these results. The chapter also included the results of the experts' questionnaire, an analysis of these results and of the comments made by the experts during the study. The results from the two questionnaires were then used to create index scores for the quality of broadband supplied to the SMEs in the study and for the economic impact that broadband has had upon them. The chapter concluded by analysing whether there was any correlation between these index scores and what could be learnt from the results.

Chapters 1-7 therefore dealt with the main tasks as outlined in the Research Aims set out in Chapter 1. This chapter considers how government policy has developed recently and what implications this research has on how broadband policy should be implemented in order for SMEs to fully benefit from the opportunities presented by access to good quality broadband. This chapter also looks at the limitations of the research and suggests further research opportunities presented by the study.

8.2 Research Findings

The thesis intentionally concentrated on the SME sector due to the fact that SMEs are a critical component of the economy in Wales and are prevalent in both rural and urban areas. As discussed in Chapter 1, there were an estimated 175,280 SMEs in Wales in 2005 representing 99.9% of all enterprises in the country. Furthermore, SMEs accounted for more than three-quarters of all employment (76.5%) and three-fifths (62.2%) of turnover.

Welsh GVA per capita is currently just above 73% of the UK average, and Wales lies at the bottom of the UK prosperity league table, 12th out of 12 UK Standard Regions (Plaid Cymru's Economic Commission, 2012). The measurable size of the UK Internet economy in 2009 was £100 billion, or roughly 7.2% of GD P. This share is larger than the country's construction, transportation or utilities industries. It is likely that the UK Internet economy will continue to grow by 10% year on year, reaching 10% of GDP by 2015. This makes the United Kingdom the world's leading country for e-commerce. However, 40% of small businesses in Wales still do not have a website and given that 97% of consumers are now using the Internet to research products and services in their local area, businesses in Wales are missing out on this Internet boom. This is a trend that needs to be reversed, and quickly if Wales based businesses are to compete with the rest of the UK in this rapidly growing sector. Only 58% of Welsh SMEs were classed as high-web users, compared to 66% for the UK as a whole, making Wales the third lowest region after Northern Ireland and the North East.

It has been widely reported by many that digital networks are the backbone of our economy, and will become increasingly so in the future. Communications technology is seen as important as it can provide access to global markets for rural SMEs (Smallbone and North, 1999). North et al. (1997) found that small businesses in rural areas tend to be less innovative and slower to adopt new technology. As such, poor telecommunications infrastructure could provide a major barrier to rural business growth and the economic success of rural SMEs. It is critical to the economic and social development of rural areas of Wales that they are not left behind and are provided with equal opportunities to prosper from the digital revolution.

The potential gains of enhanced broadband provision, in economic terms, make broadband fundamentally important. Similarly, for the industries involved, and broadband affects most if not all industries, questions arising from the roll-out of broadband infrastructure are crucial; to an increasing extent, their futures depend on this infrastructure and on the rules that govern their

access to it. Finally, for the majority of UK citizens, broadband is becoming a domestic essential, similar in many ways to other key utilities, such as water or electricity.

It is clear from Chapter 4 that a divide in broadband provision exists between urban and rural areas of Wales. Within Wales' urban centres of Cardiff, Swansea and Newport fewer than 10% of all premises are unable to access broadband at speeds higher than 2Mbps. This figure increases to more than 40% within some of Wales' rural LA areas (Point Topic, 2011). Furthermore, average download and upload speeds in Cardiff are more than double those in Ceredigion, reflecting the longer last mile distances in rural areas and the lower availability of ADSL2+ and fibre-based products. This is a significant difference in quality of service provision between the two areas.

The issue of low availability of higher-bandwidth services within Wales is likely to become increasingly important when considering recent international trends. High-bandwidth fibre based broadband services are becoming increasingly popular, particularly in North America, Asia Pacific and areas of Western Europe, as users seek greater bandwidths.

Within businesses, particularly smaller enterprises, one of the areas where demand for higher-bandwidth services will be driven will be cloud computing, i.e. the delivery of hosted services over the Internet. These services can be divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). Cloud services have three distinct characteristics that differentiate them from traditional hosting. They are sold on demand, i.e. by the minute or the hour, with little or no upfront cost; they are elastic, i.e. users can use as much or as little of a service as they want at any given time; and they are fully managed by a provider i.e. the consumer needs nothing but a personal computer and Internet access and, as such, the end user is free to use the service from any location. Services can be anything from Web-based email to inventory control and database processing. Cloud computing is particularly important to small businesses as it allows them to avoid capital expenditure (CapEx) on hardware, software, and services as they only pay a provider for what they use. Other benefits to small businesses of this approach include: low barriers to entry (thereby avoiding return on investment risk and uncertainty), shared infrastructure and costs, low management overhead, and instant access to a wide range of applications. Any inability to access the benefits that can be offered through the use of cloud computing due to poor broadband access would leave small businesses in rural Wales at a competitive disadvantage and would limit the opportunities that these technologies can provide.

The fact that rural Wales is so reliant upon DSL for broadband delivery, along with the higher proportion of premises being beyond 5km from an exchange, makes rural Wales particularly susceptible to being left behind when higher-bandwidth services are introduced by operators in the near to medium term future. Due to the nature of the copper-based telecommunications infrastructure in Wales it is clear that rural areas of Wales are disadvantaged in terms of the quality of broadband services available. Indeed, there are still a considerable number of premises which are unable to access broadband at all. Meanwhile, the increasing demand for higher-bandwidths and the low availability of higher-bandwidth services are becoming increasingly important issues in the broadband arena. Careful consideration must be given to this situation in order to ensure that rural Wales is not disadvantaged by these network limitations. It is important therefore that the promised rollout plans recently announced by the Welsh government must now be realised within the allotted timeframes.

In order to ensure that all businesses fully benefit from the use of digital technologies, action must be taken to ensure access to high quality broadband to all and to improve media literacy. Access alone is not enough; people still require the motivation and skills to use technology. The inequality in access, use and application of digital technologies is a new driver of social exclusion which risks accelerating existing social divides and creating new ones. Digital inclusion is about ensuring that all citizens have the opportunity to benefit from what digital technology has to offer, through access to technology and through the skills, motivation and confidence to use it to improve the quality of their lives. Furthermore, it is about ensuring that the indirect benefits of technology to improve all aspects of service planning and delivery are fully exploited.

Whilst there is no evidence to support the theory that economic impact increases as the quality of broadband increases, this study does provide evidence that broadband access in itself provides an economic impact for SMEs. Rather than an improvement in quality components such as download speed, upload speed and latency, the issues that currently seem to be having most impact upon SMEs' ability to prosper from broadband access are reliability and consistency of service and their lack of skills and knowledge for fully exploiting the potential that broadband access can offer. The South East Wales Economic Forum indicate in their comments to the Welsh Assembly (Written evidence submitted by South East Wales Economic Forum to the Welsh Affairs Commitee: Evidence Ev 65, 2011) that "training in the use and benefits of broadband for SMEs is as important as increasing broadband speed."

The majority of SMEs currently do not require the use of the more complex and sophisticated applications and services that require higher quality broadband services and, as such, can maximise their economic impact from broadband access with a relatively basic but reliable and consistent service. However, there are niche industries e.g. television production, where higher quality broadband services could result in greater economic impact, hence there remains a case for making higher quality services available to SMEs in Wales.

8.3 Contribution to Knowledge

Whilst the majority of studies into the economic impact of broadband infrastructure, as discussed in section 2.2, have concentrated upon a broader area macro level analysis, this thesis has proven that it is also possible to measure the economic impact of broadband at a micro level, in this instance through measuring the impact in individual enterprises. It has also shown that whilst quantitative survey led research in this subject at the micro level is useful, in order to truly understand the underlying issues arising from such research a qualitative case study approach is required.

This study has also shown, like Fornefeld (2008) and Katz (2009), that broadband access is vitally important to businesses in both urban and rural areas, and that many businesses believe that they would not be able to continue trading effectively without it. However, the thesis set out to prove the hypothesis that economic impact would improve in businesses as their broadband access quality improved. This indeed has proven not to be the case and that economic impact in businesses from broadband access is dependant as much, if not more so, upon the ability of businesses to exploit the opportunities that it provides rather than the quality of the broadband service. This is critical knowledge for policy implementation as it proves that the multi-million pound investments in broadband infrastructure within Wales, as well as throughout the world, will not realise the maximal economic benefit alone. In order to fully realise the economic benefits that broadband can provide, governments must consider implementing programmes alongside their infrastructure rollouts that will educate businesses on how to fully exploit the opportunities that they present.

The thesis also provides evidence that the requirements of SMEs are different in terms of the main parameters that make up a broadband service. The importance of each parameter to SMEs as calculated in section 7.3 is different to those presented by the Oxford Said Business School (2008) for home consumer services. This is important for service providers to consider when creating their business broadband packages and for infrastructure providers when planning their network rollouts.

It is also vital that any policy intervention considers this in order to ensure that all users are provided with the service that they require as a result of any policy intervention.

8.4 Recent Policy Developments

The Welsh Government recently announced aims to deliver Next Generation Broadband to 96 per cent of homes and businesses in Wales by the end of 2015 (Welsh Government, 2012).

The agreement from the European Commission is the largest project of its kind in the UK and is intended to make Wales a global leader in fibre broadband.The project will use public and private funds to deliver fibre broadband to parts of the country not covered by commercial plans.

The new fibre broadband will provide even faster speeds to businesses than those provided to households should businesses need it. The initiative, which is subject to State aid and major projects approval, will take the total amount invested in Welsh fibre broadband to around £425 million. The agreement exceeds the target of the UK Government to delivering faster broadband to 90 per cent of the UK population. The project will target the 52% of premises in Wales where there is no planned commercial roll out. It will build on commercial investment already made or planned by the private sector.

First Minister Carwyn Jones announced the project by emphasising the importance this project will have for businesses: *"This is an incredibly important agreement for Wales. Our partnership with BT will see to it that Wales does more than simply catch up with our neighbours; we intend to catch-up, overtake and then set the pace that others will strive to match. The project will transform the broadband landscape across Wales and ensure that local businesses can become global businesses. It will ensure that firms remain in Wales and it will also attract a more diverse range of high growth, high value companies to the country across all our key sectors from tourism to high end manufacturing.*

"It will be of particular benefit to the tens of thousands of local businesses across Wales. It will ensure that firms remain in Wales and it will also attract a more diverse range of high growth, high value companies to the country across all our key sectors."

Furthermore, Andy Kerr, Communication Workers Union deputy general secretary, stated his belief in how this improvement in broadband infrastructurewill help the Welsh economy: *"It is also a major*

vote of confidence in the skills and experience of our members who will deliver faster broadband services right across Wales. This will help stimulate the Welsh economy, create jobs and is something I feel we can all be proud of".

Whilst this project will undoubtedly solve many issues that businesses in Wales have in terms of their telecommunications services, it is important that not too much emphasis is placed upon headline download speeds provided by the new infrastructure and that other quality measures are given equal consideration as these are just as important, if not more so, to small businesses as evidenced in this thesis - the results in Chapter 7 indicate that SMEs are more concerned about future improvements in upload speed and reliability than in download speeds. This could be done by including upload speed as part of the minimum access standard, or by using a quality index method such as the one developed in this thesis, to ensure that the infrastructure delivers an all round high quality service.

The debate about the uses to which superfast speeds could be applied ranges widely and often features strong views —and in turn logically sophisticated discourse about whether these uses and services are of the kind which merit Government support for the infrastructure over which they would run. On one side, speed evangelists cite applications such as tele-health, cloud computing, and HD IPTV (Internet Protocol Television) as providing justification for public support. These, it is argued, carry significant positive externalities or 'spillover' effects, and may have considerable impact on the wider UK economy and society. These spillover effects range from the creation of new, 'distributed' industry models, and a whole variety of effects on home-working, socially isolated people and the provision of public services to remote communities. On the other side, sceptics argue that the same behaviours and industries can thrive on an infrastructure that has undergone an evolutionary upgrade, rather than a revolutionary overhaul, and so can be brought about at far lower public cost. In short, there is not yet a 'killer application' (killer app) which puts the case for wider or universal access to superfast speeds beyond all question.

Providing the infrastructure is only a start. It is clear SMEs need educating in what they can do with high-speed broadband and need training to be able to fully utilise what it has to offer.

These recommendations are largely mirrored by a recent report from the House of Lords (House of Lords, 2012) which stated:

“110. We recommend that future broadband policy should not be built around precise speed targets end-users can expect to receive in the short-term, however attractive these may be for sloganeers.

111. In addition, broadband infrastructure policy should be driven by an avowedly long-term, but also flexible view of the infrastructure's future.

112. As an overriding principle, we recommend that Government strategy and investment in broadband infrastructure should always be based on a minimum ten year horizon and possibly beyond.

113. While we acknowledge the presently elusive nature of a 'killer app,' we believe there is a clear need for the Government to state in explicit terms a long-term vision for a pervasive, robust and resilient broadband infrastructure, central to national policy and infrastructure planning.

114. We anticipate and recommend that policy should be ultimately directed towards universal, point-to-point FTTP as this is a technology not only able to accommodate current demand, but at current rates of growth, will be able to accommodate the UK's bandwidth demands for many decades to come.”

Meanwhile, Ofcom has said that 4G should be available to up to 99% of mobile phone users in Wales. Elinor Williams, of Ofcom in Wales, said people would benefit greatly: *"The introduction of 4G will be revolutionary in areas of rural Wales which currently have no mobile coverage or intermittent coverage,"*

"It will be particularly useful to businesses in remote rural areas and for people such as farmers. It'll mean that they can conduct their business from a hand-held device when they would have previously had to use a personal computer in their home”

This would mean that coverage of 4G would be higher than 3G coverage in Wales, which stands at 97.6%. Currently 2.4% of Wales has no 3G coverage, and rural counties such as Powys, Ceredigion and Anglesey in particular have experienced poor mobile phone coverage (Ofcom, 2011). Ofcom hopes 98% of the UK will have 4G coverage by 2017.

Farmer's son Nick Fenwick, who grew up on a hill farm in Llanbrynmair, near Machynlleth, Powys, with poor mobile coverage said the introduction of 4G would be hugely beneficial to farmers.

Mr Fenwick, who is director of agricultural policy at the Farmers' Union of Wales said: *"The farming industry, in increasing numbers, is reliant on smart phone technology such as apps. It's second nature for the up-and-coming younger generation to use their phones in innovative ways. Farmers receive emails on their phones and check the internet for the latest prices for things like livestock feed. Improvements in technology such as 4G, which will improve coverage and data transfer, will be hugely beneficial for farmers."*

Regulators need to recognise that many rural areas suffer from a lack of competition in the telecommunications market and the communications regulator Ofcom's stated aim "*to have encouraged the development of an environment in which there is much more competition and innovation in broadband networks and services*" (Ofcom, 2005) may not always work in these areas where monopoly situations have arisen. Consequently, Ofcom should consider regulating these areas differently so that they are not disadvantaged by regulation designed for competitive markets.

8.5 Implications of the Research

The recent developments discussed in section 8.4 will go a long way to solving the issues of poor communications service in rural Wales. Without government intervention more than half of Welsh premises would not get access to high speed broadband as commercial rollouts targeted the urban areas, but thanks to this funding all but the most remote premises will have access to fibre-based high-speed broadband as well as mobile internet access. Not only will this allow rural areas of Wales to catch up in terms of communications service coverage with urban areas of Wales and the rest of the UK, but it will indeed put Wales ahead of the rest of the UK and many other European nations.

However, the infrastructure issue is only a part of the problem. Whilst policy intervention in Wales, such as those discussed in section 8.4, is currently focused upon providing infrastructure, in order to ensure that the services available to SMEs over this infrastructure are fully utilised, SMEs need to be educated in how to exploit the services and applications that will now become available to them. As seen in chapter 6, many SMEs do not currently believe that they have the skills and knowledge to take full advantage of their current broadband services and this will increase as more sophisticated services become available over the improved infrastructure.

High quality broadband infrastructure is an enabling technology that allows users to exploit applications and services for economic and social benefit. Access alone to such infrastructure will not create economic benefit, rather it is the ability to use the available applications and services that will enable businesses to exploit the opportunities provided by access to high quality broadband. It is clear from the research undertaken in this study that many businesses in Wales do not have the necessary skills and knowledge to fully exploit their current basic broadband services never mind the sophisticated opportunities provided by higher quality services. Improvements in this area are likely to occur over time without any policy intervention, however, this could lead to a time lag of many years between the provision of infrastructure and the ability of businesses to fully exploit its potential. Consequently, for Wales to fully benefit economically from its infrastructure investment it must also invest in educating and encouraging small businesses to utilise the opportunities that it presents.

It is also important that any progrmamme that encourages the use of higher quality broadband services focuses upon business' need for better understanding of the benefits associated with higher quality broadband access rather than focussing on the issues of 'faster' broadband and higher download capabilities which many businesses will find difficulty in associating with. An understanding of these benefits and how they relate to business processes will enable businesses to appreciate the economic opportunities that they present.

8.6 Limitations of the Research

Throughout the analysis of this research study a number of limitations have become evident. Firstly, the small sample of businesses who completed the questionnaire, and the even smaller number who were willing to undertake a case study interview, made it impossible to undertake a matched pair analysis of businesses and limited the amount of data that was available to be analysed.

Furthermore, only one of the businesses involved in the study has a true 'superfast' service, whilst the majority had average basic service and, consequently, the majority of samples provided BIS scores that were in a very limited range. The resulting low variance of quality in broadband access therefore limited the ability to prove any link between varying broadband quality and economic impact.

Since the availability and adoption of higher quality services has improved in the time since the research was undertaken it is possible that this limitation would be overcome if the research was to be repeated at present or in the near future. However, this study suggests that there is little evidence to support the hypothesis that economic impact differs through varying broadband quality alone and that the ability of businesses to utilise their broadband access is a key factor in deriving economic benefit from broadband access. As such, it is unlikely that repeating the study in its present form, with this limitation removed, would prove the hypothesis and that any changes in the results could be attributed to an improvement in skills and knowledge over time as much as to an improvement in broadband quality.

Additionally, it was apparent from the case study interviews that most economic impact associated with broadband access is derived from basic applications and services. As such, it is difficult to assess the difference in impact between basic and superfast services. In order to better understand the impact of higher speed services, a study looking at the impact of non-basic applications could be conducted whereby the impact of basic applications such as email and web browsing would not be considered, as an improvement in broadband quality would not significantly improve the performance of these basic applications.

In terms of measuring broadband quality, one limitation was that the one off measurement may not have given a true reflection of the service quality over time. Some businesses indicated that their connections were inferior for running some applications or services whilst others weren't, which indicates that a one off measurement of the broadband service is failing to highlight other issues such as inconsistency in service levels and/or reliability of the service. An approach using measurements over a period of time may be considered to counter this issue. This could be done using a software package that would monitor the service quality over a period of time, allowing a better representation of the true service level to be ascertained rather than a one off measurement.

8.7 Further Research Opportunities

It should be noted that the majority of economic gains resulting from broadband access appear from this thesis to be achieved from using the basic applications and services such as email, website provision and online store provision rather than more sophisticated services such as video conferencing. Consequently, in order to evaluate the economic impact created by high quality broadband compared to basic quality broadband a more appropriate approach may be to disregard

the basic applications and services from a study and research the impact created by the use of sophisticated services alone. These impacts may seem minor in comparison to those achieved through use of the basic applications and services, but could appear significant when studied alone. Such a study should take a longer term view and run alongside an initiative for increasing sophisticated broadband use in small businesses in order to see how increased use of these services impacts economically upon small businesses.

As such, this provides an opportunity to undertake research, to measure the impact of advanced applications and services alone, without the basic applications and services, in order to better ascertain the impact of superfast over basic broadband.

Additionally, research should be undertaken to establish the requirements of SMEs so that they are sufficiently competent in exploiting the benefits of high quality broadband. Furthermore, an awareness programme should be created to deliver advice to SMEs. This could take the form of an online and/or mobile application service to distribute knowledge and to enable SMEs to share ideas , which may also generate new business ideas and opportunities and promote innovation.

A two-phase questionnaire study, carried out both before and after training and education, could provide important insights not only into the importance of quality but also the perceptions thereof.

8.8 Conclusion

During the time since commencing this research in 2009 it is clear that policymakers have now understood the economic importance of good quality broadband infrastructure and the need to intervene in order to provide this infrastructure in areas that are not attractive to commercial providers. It is also clear that broadband can benefit SMEs in many ways and the cumulative effect of this can create a positive economic impact upon regional areas and nations.

However, the infrastructure alone will not be sufficient to fully realise the potential benefits that broadband provides as SMEs need encouragement to use applications and services as well as being educated as to what these applications can do for them and in how to use them. Such a programme to aid SMEs has had little mention from policymakers despite being an essential part of fully realising the potential of broadband for SMEs.

Consequently, the challenge for the Welsh Government will now not only be to deliver on its promise to bring high quality broadband infrastructure to the majority of premises in Wales, but also to ensure that businesses in Wales are in a position to make the most of this infrastructure by the time it is in place.

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Glossary of Technical Terms

Transmission Control Protocol - the protocol used by major Internet applications such as the World Wide Web, email, remote administration and file transfer.

Hypertext Transfer Protocol - an application protocol for distributed, collaborative, hypermedia information systems and the foundation of data communication for the World Wide Web.

Domain Name System - a hierarchical distributed naming system for computers, services, or any resource connected to the Internet or other private network.

Appendix A: United Nations Millennium Development Goals.

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce Child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development.

Appendix B: Economic Benefits of Broadband in SMEs Survey

1. Please enter your email address:.....

2. Please enter the postcode of your premises:.....

3. In which industry sector does the main activity of your business operate?.....

4. How many employees (full-time equivalents) does your business have?.....

5. What type of broadband connection does your business use?

1. No broadband connection ☐
2. Mobile device ☐
3. ADSL/DSL (i.e. via a telephone line) ☐
4. Cable modem ☐
5. Leased line ☐
6. Wireless broadband ☐
7. Satellite broadband ☐
8. Don't know/Other ☐ (If 'Other' please specify).....

6. What is the actual bandwidth provided by your broadband connection?

Please access this link (http://www.speedtest.net ***) and click on the 'Begin Test' button. Once the test has run please fill in the following:***

Please write:

Download .....Mb/s
Upload.....Mb/s

7. What is the actual quality of service provided by your broadband connection?

Please access this link (http://www.pingtest.net ***) and click on the 'Begin Test' button. Once the test has run please fill in the following:***

Please write:

Packet loss.....%
Ping.....ms
Jitter.....ms

8. On a scale of 1-5, how strongly do you agree/disagree that the quality/reliability of your existing broadband service is satisfactory?

	Strongly Agree				Strongly Disagree
	1	2	3	4	5
	☐	☐	☐	☐	☐

9. On a scale of 1-5, how strongly do you agree/disagree that your broadband connection has allowed your business to undertake or improve the following processes?

	Strongly Agree				Strongly Disagree
	1	2	3	4	5
1. Ability to accept online payments	☐	☐	☐	☐	☐
2. Ability to undertake research	☐	☐	☐	☐	☐
3. Access to online services and applications	☐	☐	☐	☐	☐
4. Ability to source and purchase supplies online	☐	☐	☐	☐	☐
5. Communication with customers	☐	☐	☐	☐	☐
6. Ability to use online training tools	☐	☐	☐	☐	☐
7. Ability to market to a wider marketplace	☐	☐	☐	☐	☐
8. Efficiency of marketing	☐	☐	☐	☐	☐
9. Ability to transfer large files quickly	☐	☐	☐	☐	☐
10. Other	☐	☐	☐	☐	☐

(Please specify).....

10. Do you operate the following applications/services over your Internet connection?

Please tick **all** that apply:

	Use	*Choose not to use*	*Don't use due to inferior quality broadband connection*
1. Website	☐	☐	☐
2. On-line store/shop provision	☐	☐	☐
3. Receiving on-line payments	☐	☐	☐
4. CRM (Customer Relationship Management)	☐	☐	☐
5. SCM (Supply Chain Management)	☐	☐	☐
6. Video Conferencing	☐	☐	☐
7. VoIP (e.g. Skype)	☐	☐	☐
8. On-line Banking	☐	☐	☐
9. Google Applications	☐	☐	☐
10. eBay (or other online auction site)	☐	☐	☐
11. Other Applications employed (please specify in the text box)			

11.a. On a scale of 1-5, how strongly do you agree/disagree that your business has experienced benefits in the following categories directly, or indirectly, through the ability to use a broadband connection?

	Strongly Agree				**Strongly Disagree**
	1	**2**	**3**	**4**	**5**
1. Cost savings	☐	☐	☐	☐	☐
2. Time savings	☐	☐	☐	☐	☐
3. Increased customer satisfaction	☐	☐	☐	☐	☐
4. Improved product design	☐	☐	☐	☐	☐
5. Higher customer retention	☐	☐	☐	☐	☐
6. New business opportunities	☐	☐	☐	☐	☐
7. More efficient internal operations	☐	☐	☐	☐	☐
8. Higher skilled workforce	☐	☐	☐	☐	☐
9. None	☐	☐	☐	☐	☐
10. Other	☐	☐	☐	☐	☐

(Please specify).....

11.b. On a scale of 1-5, how strongly do you agree/disagree that benefits to your business will be achieved in the future in the following categories directly, or indirectly, through the ability to use a broadband connection?

		Strongly Agree				Strongly Disagree
		1	**2**	**3**	**4**	**5**
1.	Cost savings	☐	☐	☐	☐	☐
2.	Time savings	☐	☐	☐	☐	☐
3.	Increased customer satisfaction	☐	☐	☐	☐	☐
4.	Improved product design	☐	☐	☐	☐	☐
5.	Higher customer retention	☐	☐	☐	☐	☐
6.	New business opportunities	☐	☐	☐	☐	☐
7.	More efficient internal operations	☐	☐	☐	☐	☐
8.	Higher skilled workforce	☐	☐	☐	☐	☐
9.	None	☐	☐	☐	☐	☐
10.	Other	☐	☐	☐	☐	☐

(Please specify).....

12. On a scale of 1-5, how strongly do you agree/disagree that the following have increased in your business due to broadband?

		Strongly Agree				Strongly Disagree
		1	**2**	**3**	**4**	**5**
1.	Productivity	☐	☐	☐	☐	☐
2.	Turnover	☐	☐	☐	☐	☐
3.	Profit	☐	☐	☐	☐	☐
4.	Target marketplace	☐	☐	☐	☐	☐
5.	Number of employees	☐	☐	☐	☐	☐

13. Are the following continuing to increase or were gains only attained in the first year of using a broadband connection?

	Continuing	First year only	No increase
1. Productivity	☐	☐	☐
2. Turnover	☐	☐	☐
3. Profit	☐	☐	☐
4. Target marketplace	☐	☐	☐
5. Number of employees	☐	☐	☐

14. On a scale of 1-5, how strongly do you agree/disagree that your business possesses the skills and knowledge to fully utilise your broadband connection?

Strongly Agree				Strongly Disagree
1	2	3	4	5
☐	☐	☐	☐	☐

15. On a scale of 1-5, how strongly do you agree/disagree that your business could continue to operate efficiently without broadband access?

Strongly Agree				Strongly Disagree
1	2	3	4	5
☐	☐	☐	☐	☐

16. On a scale of 1-5, how strongly do you agree/disagree that your business could operate better with an improved broadband connection?

Strongly Agree				Strongly Disagree
1	2	3	4	5
☐	☐	☐	☐	☐

17. On a scale of 1-5, how strongly do you agree/disagree that improvements in the following components of your broadband connection will be important for your business in the future?

		Strongly Agree 1	2	3	4	Strongly Disagree 5
1.	Download speed	☐	☐	☐	☐	☐
2.	Upload speed	☐	☐	☐	☐	☐
3.	Reliability	☐	☐	☐	☐	☐

If you would like to comment further regarding your broadband access please include them in this text box:

Thank you for completing the questionnaire. Your participation is greatly appreciated.

Please check this box if you are willing to undertake a case study interview in order for me to gain a deeper understanding of the issues facing your business ☐

Please check this box if you would like to receive an Executive Summary of the findings of the research ☐

Appendix C: Broadband Quality in SMEs: Experts' questionnaire – Round 1

Taking into consideration the applications and services used by, respectively, SMEs and consumers, over their broadband connection, both currently and in the foreseeable future, please indicate the importance you believe should be assigned to the three individual quality indicators specified below in percentage terms.

	Weighting SMEs (%)	Weighting Consumers (%)
Download Speed		
Upload Speed		
Latency		
	100%	100%

Please explain why you have chosen this weighting in the text box:

Many thanks for contributing to the first round of this questionnaire study. The second and final round will be sent to you as soon as the results from this first round have been collated.

Appendix D: Broadband Quality in SMEs: Experts' questionnaire – Round 2

Your results from the first round questionnaire were as follows:

	Weighting SMEs (%)	Weighting Consumers (%)
Download Speed		
Upload Speed		
Latency		
	100%	100%

The averaged results of all experts from the first round questionnaire yielded the following:

	Weighting SMEs (%)	Weighting Consumers (%)
Download Speed		
Upload Speed		
Latency		
	100%	100%

Experts' comments from the first round questionnaire:

Having considered the results and comments from the first round questionnaire, please reconsider your weighting for the quality indicators and indicate your revised weighting in the table below:

	Weighting SMEs (%)	Weighting Consumers (%)
Download Speed		
Upload Speed		
Latency		
	100%	100%

Many thanks for contributing to this study.

Please indicate as appropriate whether you would like to receive an Executive Summary of the findings of this research study: YES/NO

Please indicate as appropriate whether you are willing to have your name and a brief description of your expertise included in the final thesis (your individual answers and comments will not be attributable to yourself in any published work that may result from this study in order to protect the privacy of your views): YES/NO

Appendix E: Comments from Panel Questionnaire

Expert 1. The consumer experience is moving from a passive receiver of information (music, films documents) to one of a provider (sharing of videos, pictures etc through social networking) and a higher upload speed is required. The consumer at home will also be increasingly utilising the broadband connection for work related tasks and uploads will be just as important as downloads. Media rich files will require higher upload bandwidth speeds to ensure acceptable times for uploads. The use of video in realtime communication services will increase, again requiring suitable upload and download speeds and suitable latency will be required. Online gaming is an increasing and suitable latency is required. A typical consumer household will most certainly have more than one online user at any one time so increasing the demand on the broadband service.

SMEs would require a more balanced download and upload connection and latency would not be so much of an issue. It is difficult to judge how much "convergence" will take place with the broadband connection being utilised for all business services including VOIP and then latency would be more of an issue.

Expert 2. Overall I think that download speed is essential for both consumers and for SMEs. However some SMEs will be producers of content and will need high upload speeds. For example graphic designers and photographers will need to share their work with their collaborators. All producers of content will need high upload capacity to distribute their products.
The majority of SMEs will, in my opinion, be consumers of content rather than producers.
I have interpreted latency as predominantly network latency – manifested as the amount of time it takes before there is a response. High latency is an irritation.
The SMEs that might be particularly affected by high latency are those using some form of online conferencing or meeting – especially if they use it to demonstrate their products, whereas online gamers are possibly the most affected consumers.

Expert 3. To some extent , for both SMEs and Consumers, the answers really depend on what it is you're actually using the BroadBand connection for :-

Network latency can be a problem for Consumers who are using networked Gaming services (such as onLive in USA http://www.onlive.com) , even more so in multi-user 'real time' games,. The same might be true for an SME using network simulation/graphics modelling tools. VOIP services such as

Skype are also sometimes prone to network latency – rarely on 1 to 1 basis, but the Quality of Service of multi-user conferencing when combining voice, webcams, screenshares, & Instant Messaging is clearly dependent on latency : this is something that an SME working in a collaborative environment would find particularly important. [Network latency only applies to 'real-time' and 'near real-time' applications].

Download speeds. For both SME and Consumer, historically, volumes of data being downloaded have exceeded the upload quantities, a fact reflected in the directional imbalance of ADSL. Download is clearly something that is happening far more frequently than uploading and so of far more general importance.

For visually 'interactive' services (the sort of things you use a web-browser for) speed is of paramount importance – user 'experience' is everything in the online market place – if download time from one site is slow you just click on a faster one ! Much effort has gone into Web Developer technology to improve and simulate faster downloads e.g. AJAX : this just goes to show how important download speed is considered to be by collective industries. Newer versions of HTML, (version 6 recently released) make the need for ever increasing volumes of data to be downloaded faster. The same arguments apply for 'batch' downloads but the impact is less critical (if it mattered they wouldn't be batch de facto).

Upload Speed. Consumer upload volumes have been negligible for interactive services and relatively small for batch services such as email. Upload speed becomes an issue for SMEs, such as our own (which is why I've scored this high-ish), when large data volumes are being frequently uploaded to remote servers; I imagine this is not generally the case for a typical SME i.e. one just using email and occasional uploads to their website.

Expert 4. For SMEs, the overall importance of having good quality broadband connection is in fact much more important than for consumers (possibly by a factor of 2 or 3?), so it is slightly misleading to find some of the percentages lower in the SME column. Nevertheless – the balance of factors is what you are looking for.

So, for the SME, the 3 factors you have asked about have roughly equal importance. SMEs will be more likely than consumers to carry out high volumes of uploading, for instance updating their websites, sending out customer information, marketing communications, organising delivery agents

etc etc. In this environment latency will be very important, both in communications with their suppliers and with customers – the latter may get irritated with slow response times, and abort their transactions, resulting in lost business.

For the consumer, the greatest volumes of transactions will be incoming rather than outgoing, most consumers, whether shopping, downloading entertainment, or just browsing, will be receiving for more data than they are generating - most of which will be fairly large files – film, video, photographs, all capacity-hungry. The average consumer will not be generating many very large files, so download outweighs upload by a considerable margin.

Finally, I would like to suggest that you consider a 4th measure of quality – that of reliability of connection. For consumers this is often extremely inconvenient and frustrating, but for SMEs it is fundamental to their businesses – time unconnected equals business lost!

Expert 7 - Overall I think that download speed is essential for both consumers and for SMEs.
However some SMEs will be producers of content and will need high upload speeds. For example graphic designers and photographers will need to share their work with their collaborators. All producers of content will need high upload capacity to distribute their products.
The majority of SMEs will, in my opinion, be consumers of content rather than producers.
I have interpreted latency as predominantly network latency – manifested as the amount of time it takes before there is a response. High latency is an irritation.
The SMEs that might be particularly affected by high latency are those using some form of online conferencing or meeting – especially if they use it to demonstrate their products. Whereas online gamers are possibly the most affected consumers.

Appendix F: Graphs relating to the analysis of the responses to the SME Questionnaire

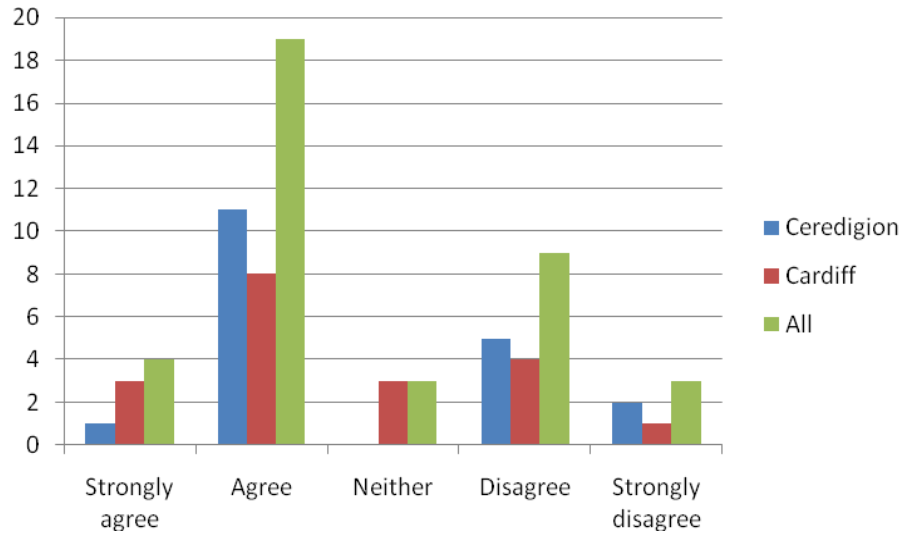

Figure F.1 – How strongly do you agree/disagree that the quality/reliability of your existing broadband service is satisfactory?

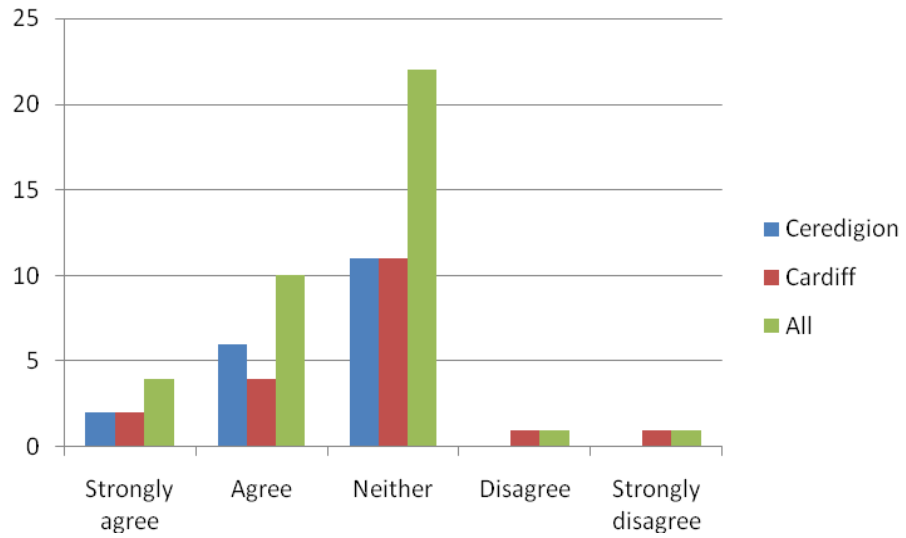

Figure F.2 – Ability to accept online payments

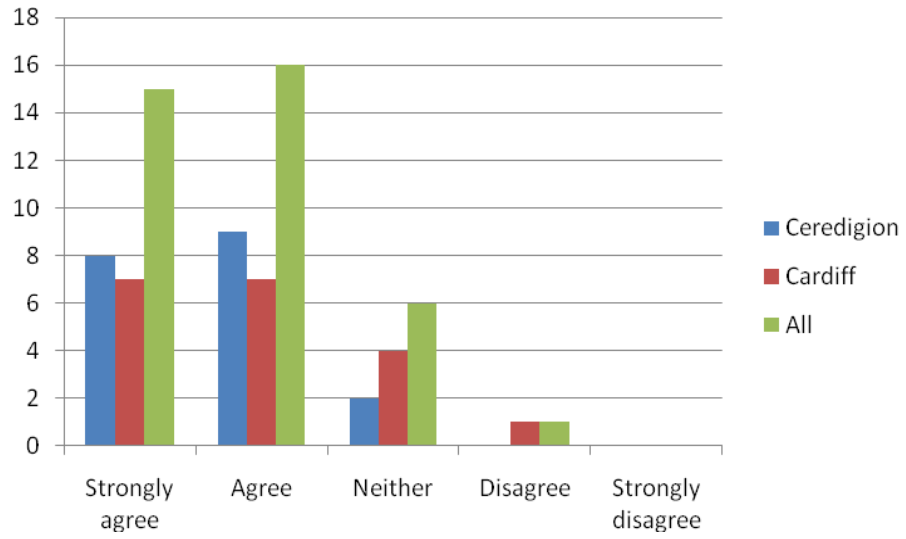

Figure F.3 – Ability to undertake research

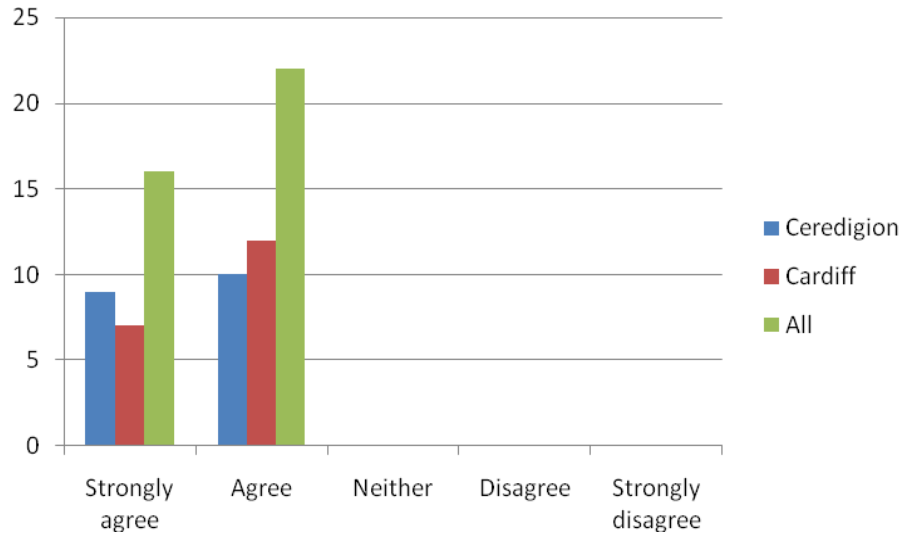

Figure F.4 – Ability to source and purchase supplies online

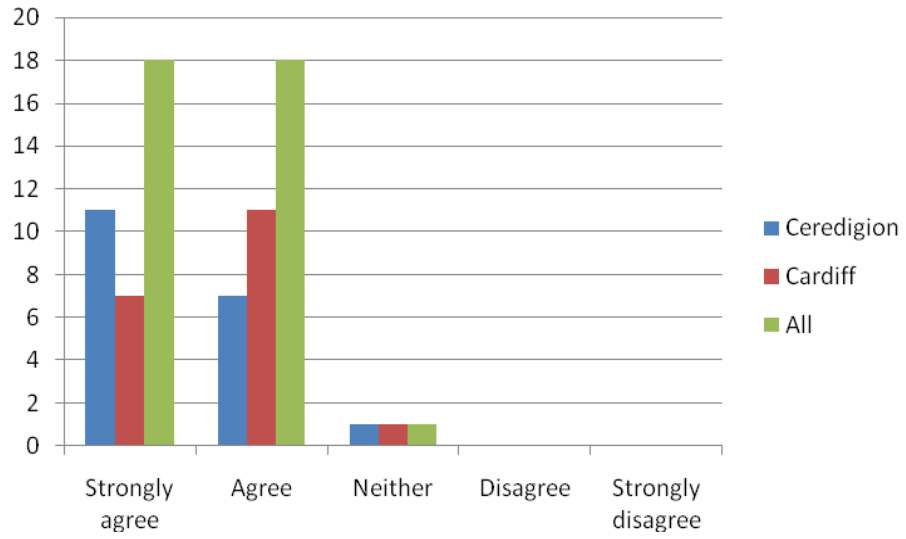

Figure F.5 – Communication with customers

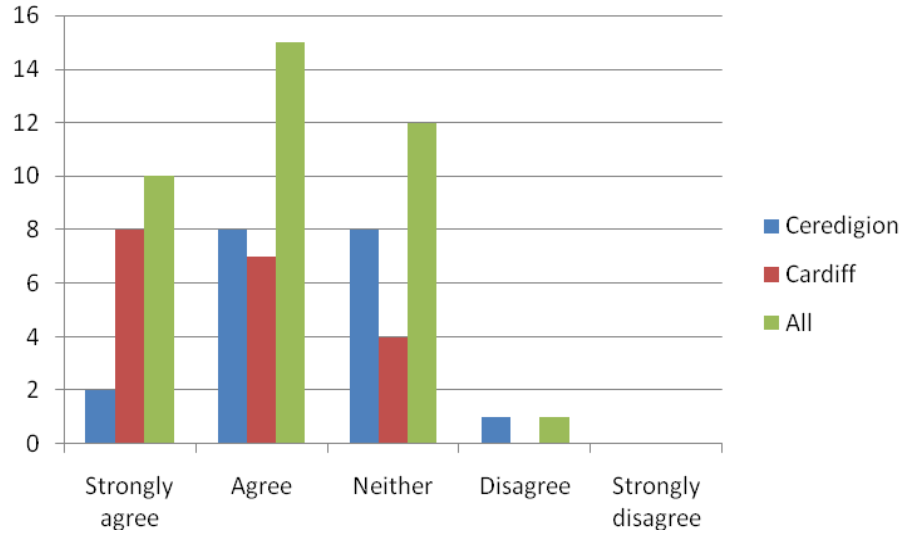

Figure F.6 – Ability to use online training tools

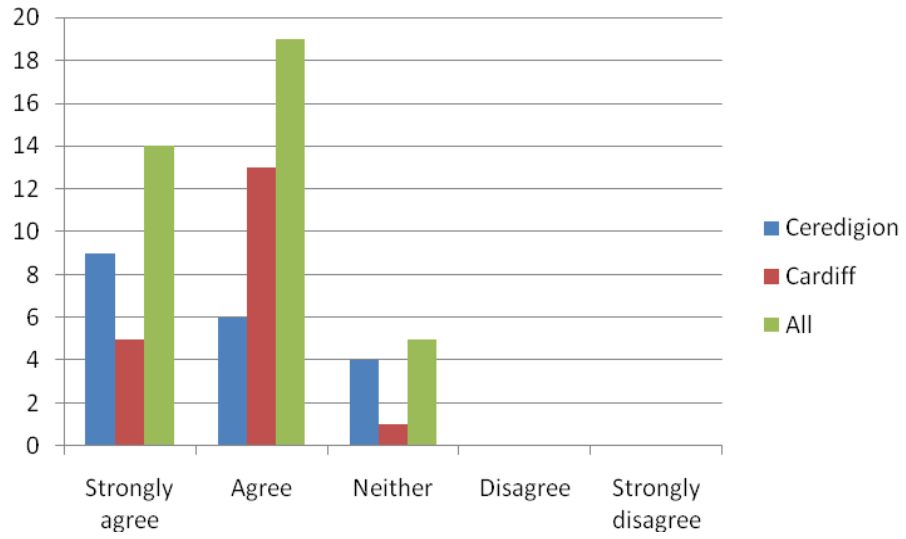

Figure F.7 – Ability to market to a wider marketplace

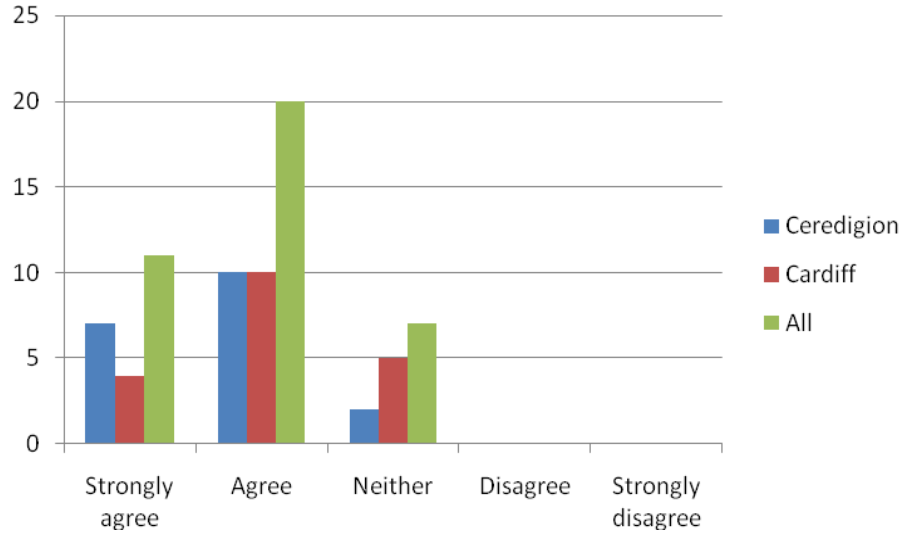

Figure F.8 – Efficiency of marketing

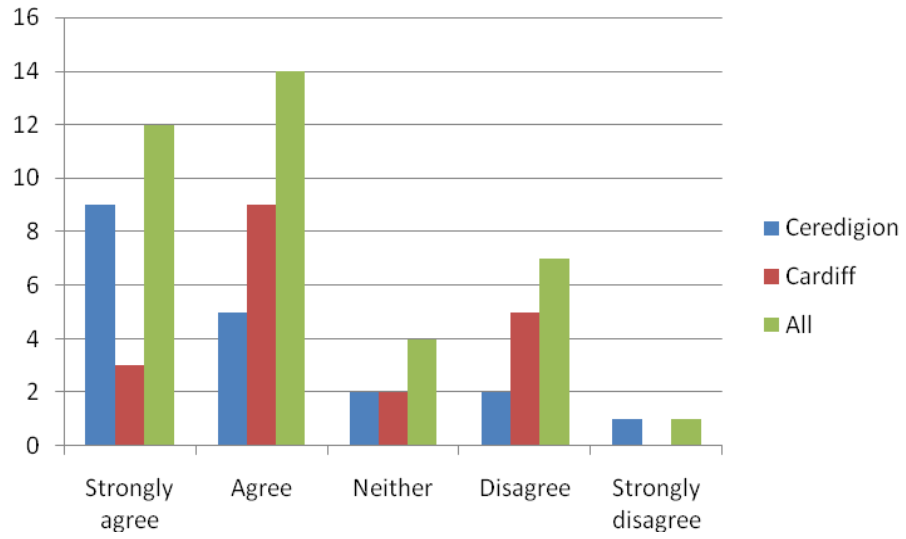

Figure F.9 – Ability to transfer large files quickly

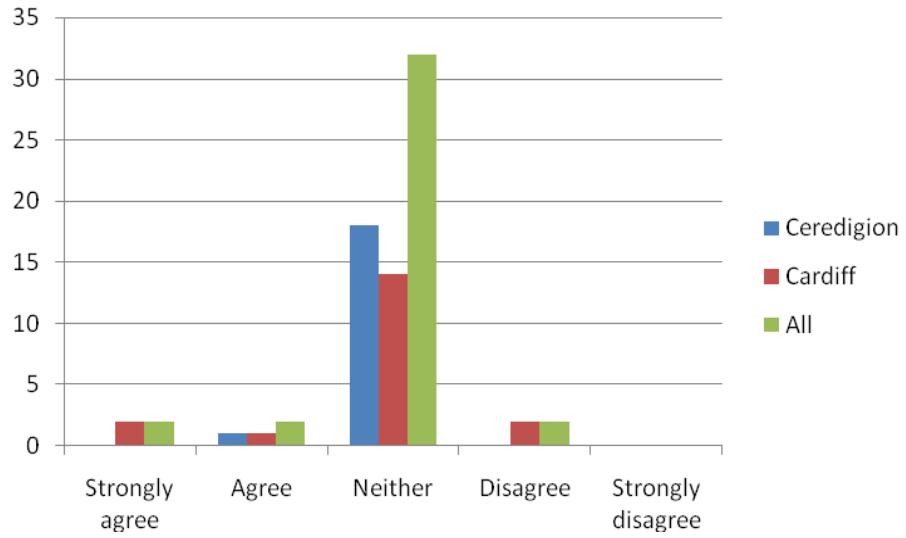

Figure F.10 – Other

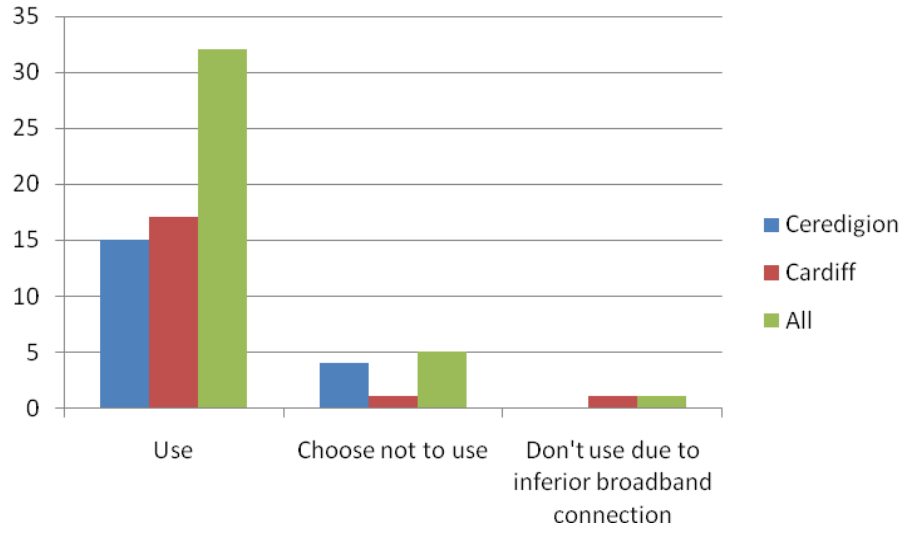

Figure F.11 – Website

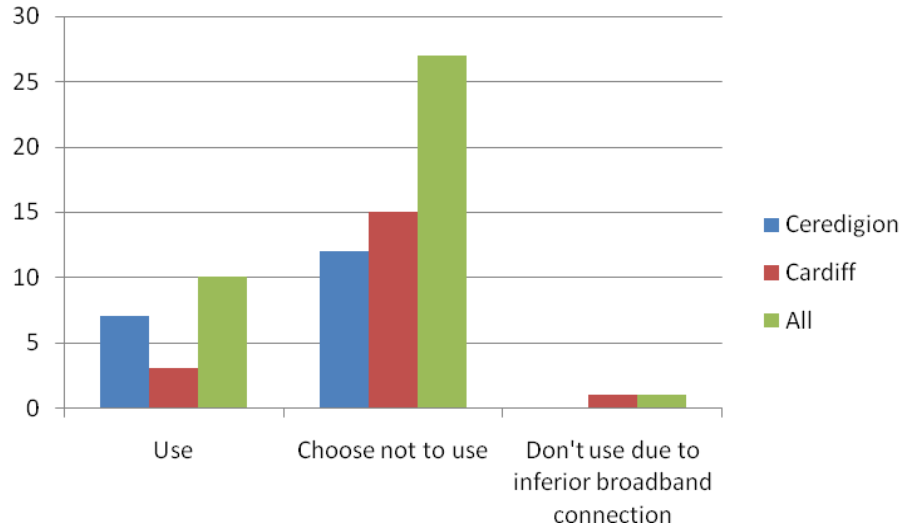

Figure F.12 – Online store/shop provision

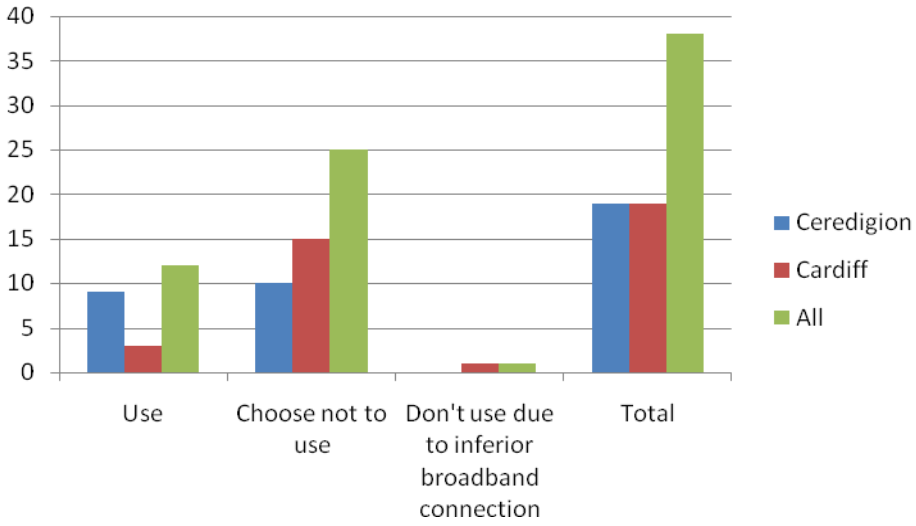

Figure F.13 – Receiving online payments

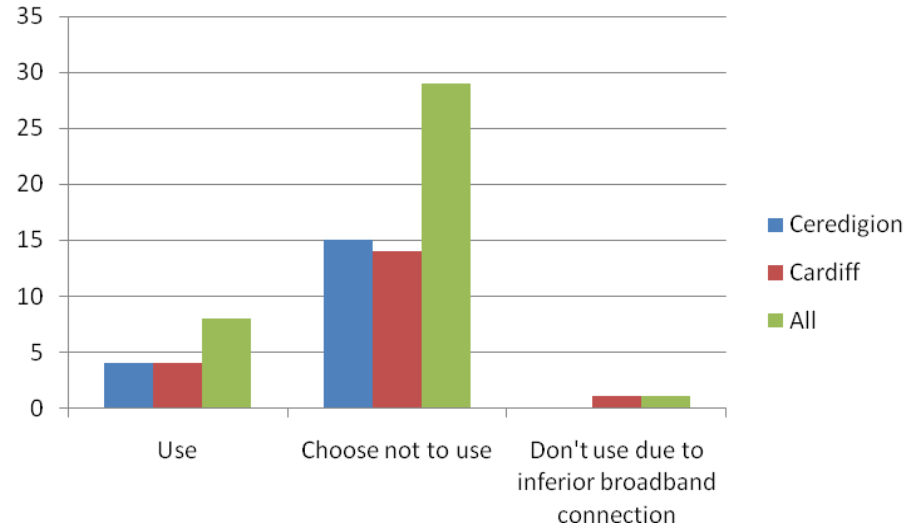

Figure F.14 – CRM

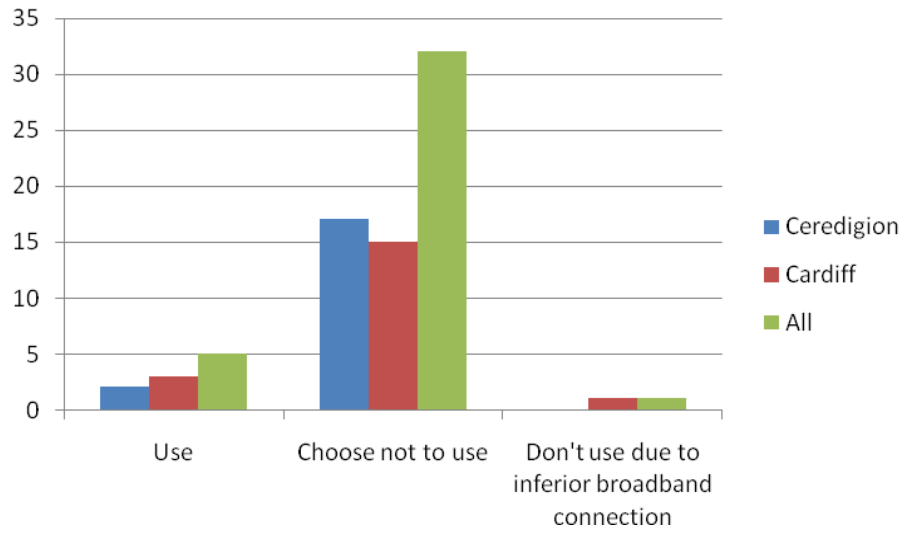

Figure F.15 – SCM

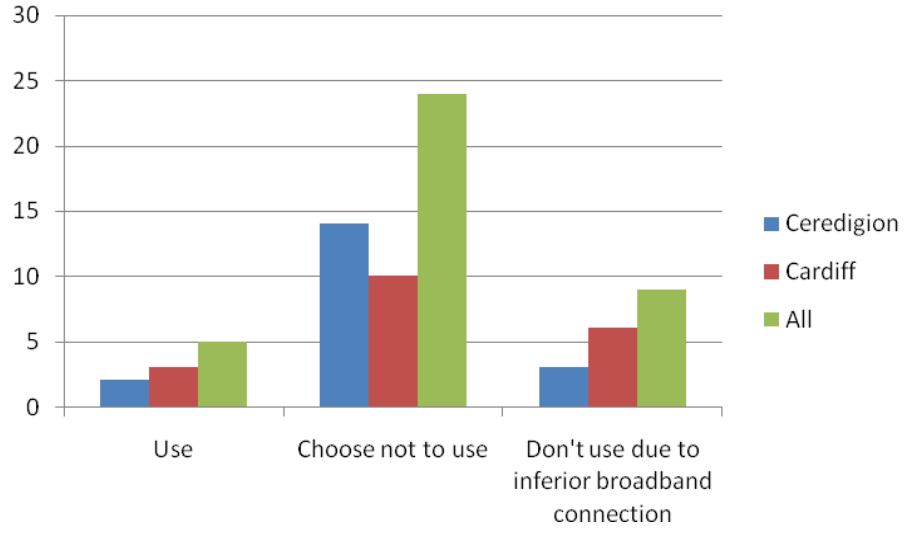

Figure F.16 – Video conferencing

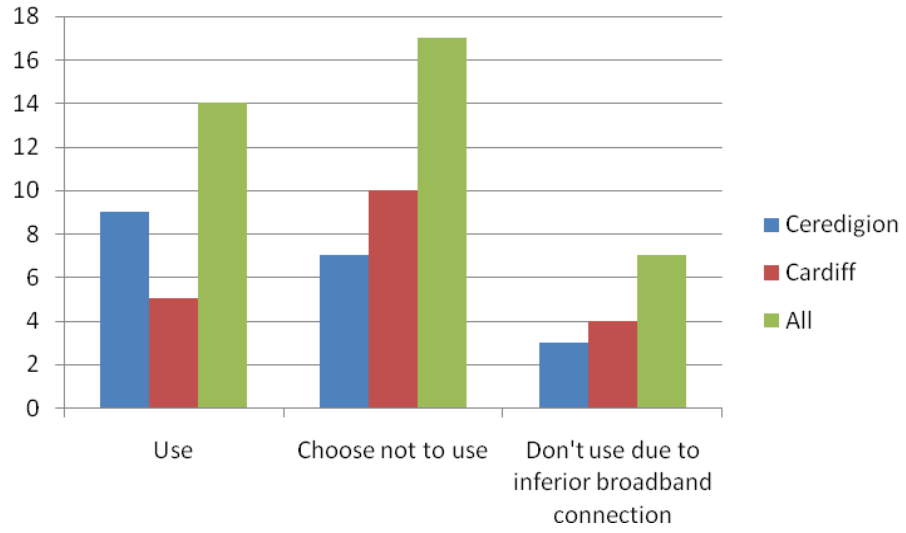

Figure F.17 – VoIP

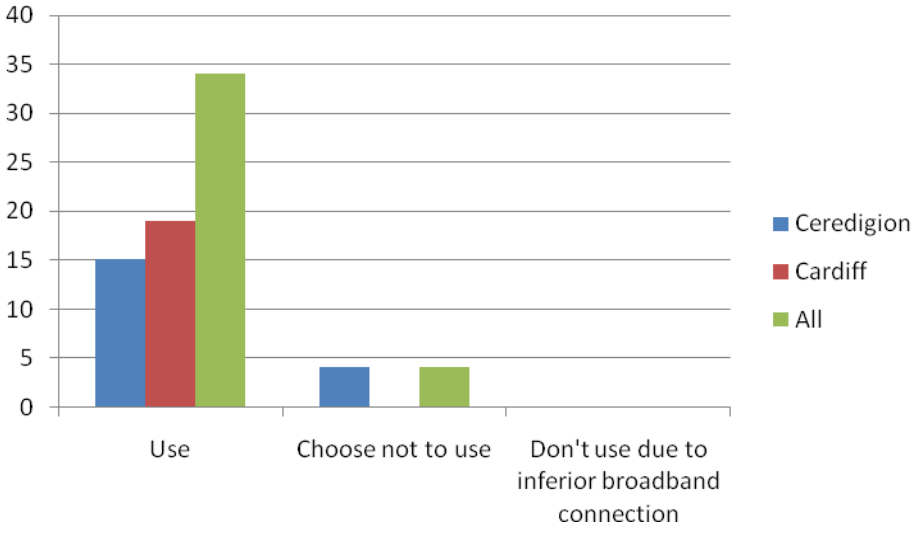

Figure F.18 – Online banking

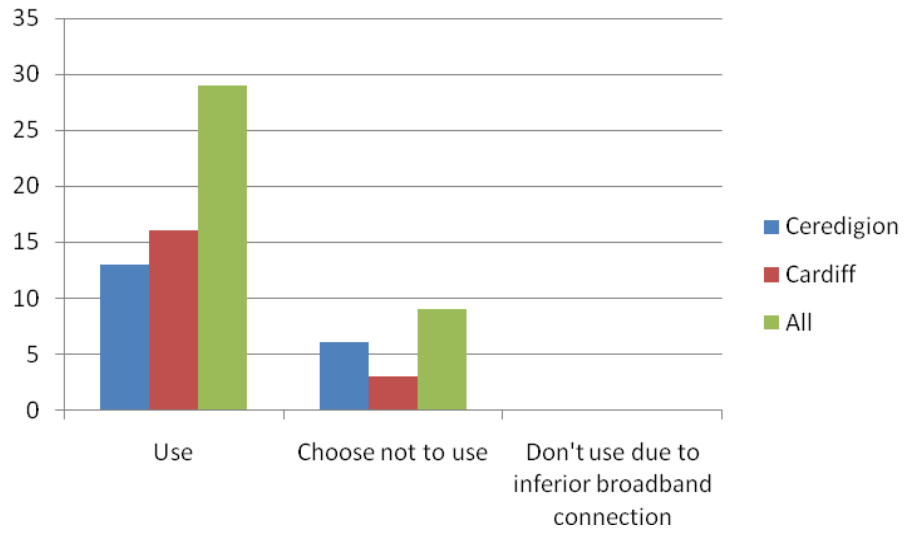

Figure F.19 – Google applications

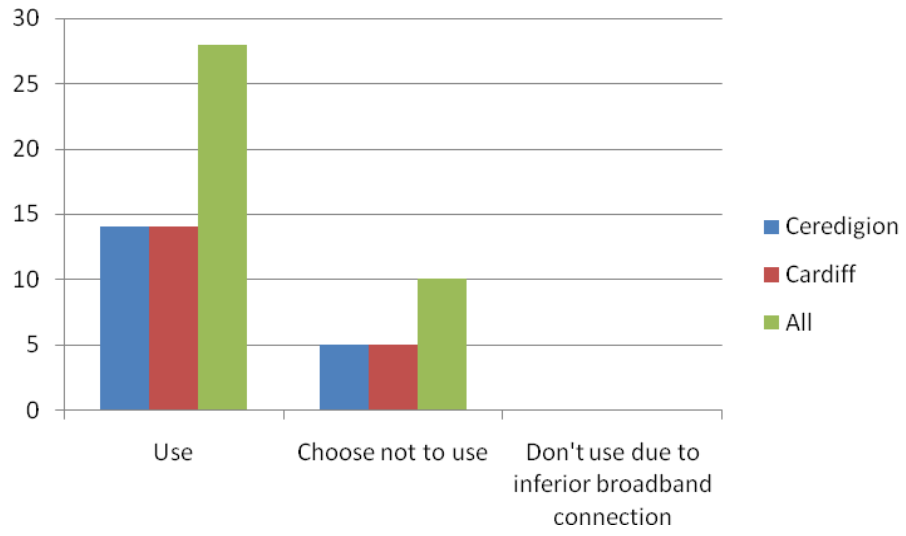

Figure F.20 – eBay (or other auction sites)

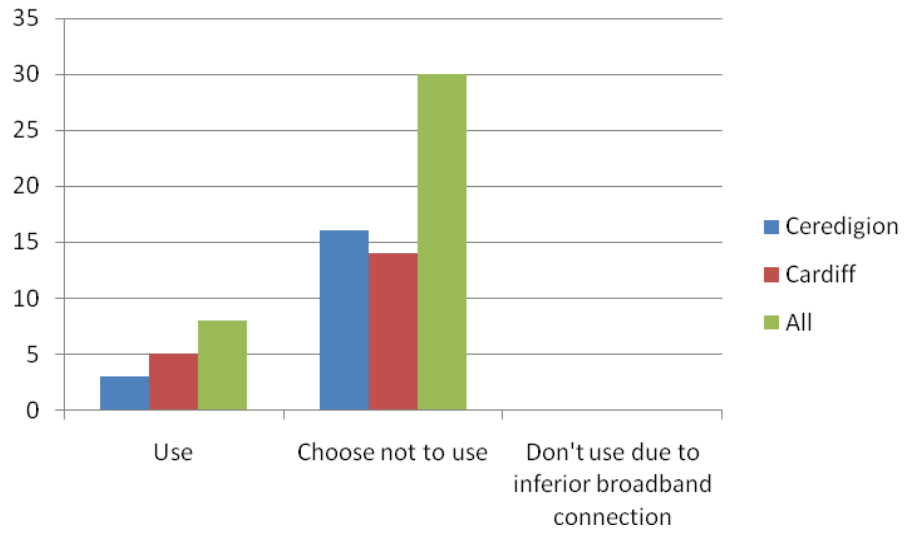

Figure F.21 – Other applications employed

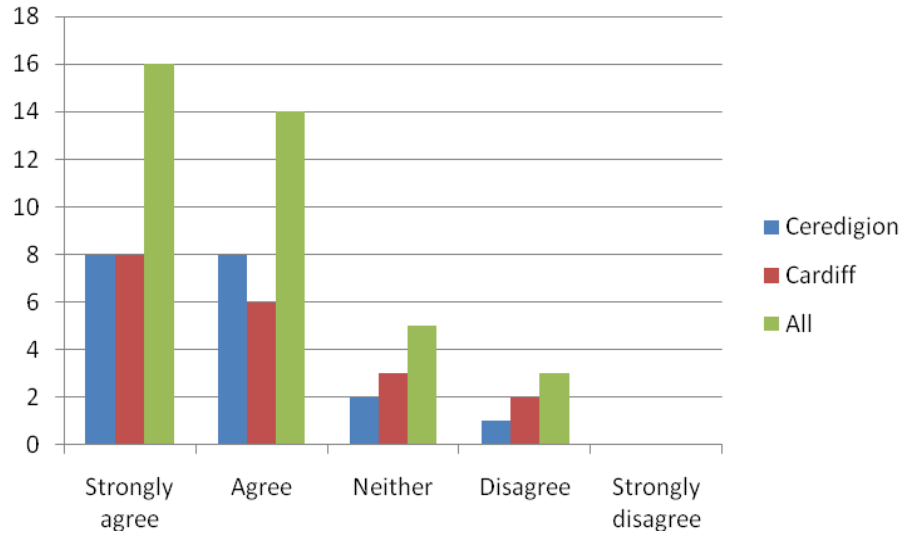

Figure F.22 – Cost savings

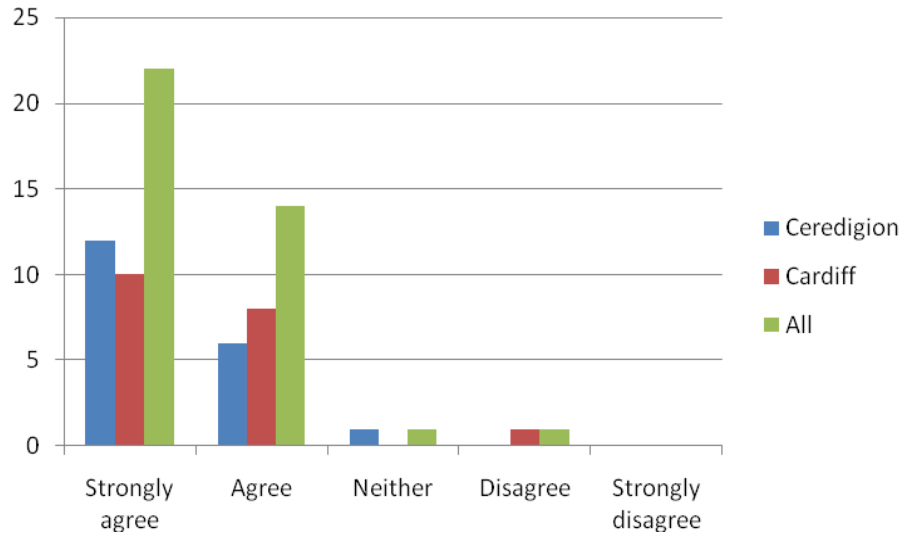

Figure F.23 – Time savings

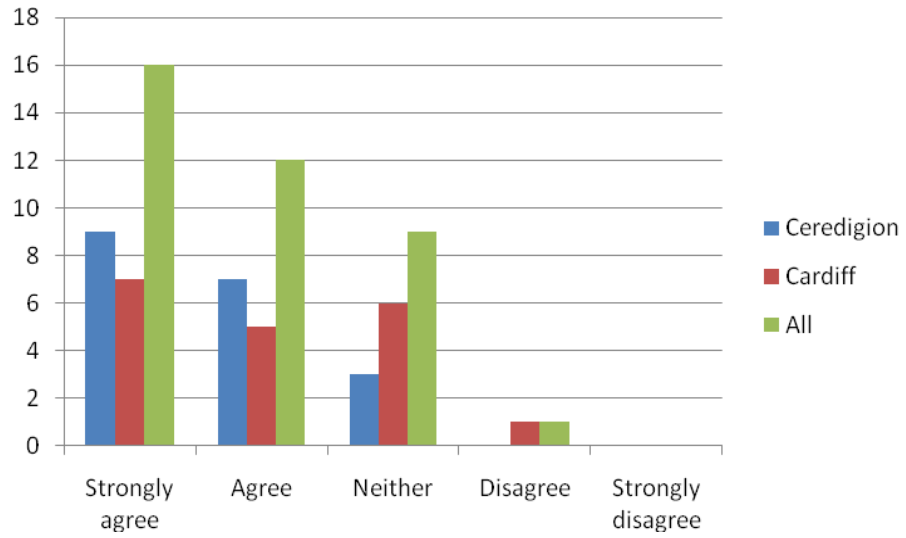

Figure F.24 – Increased customer satisfaction

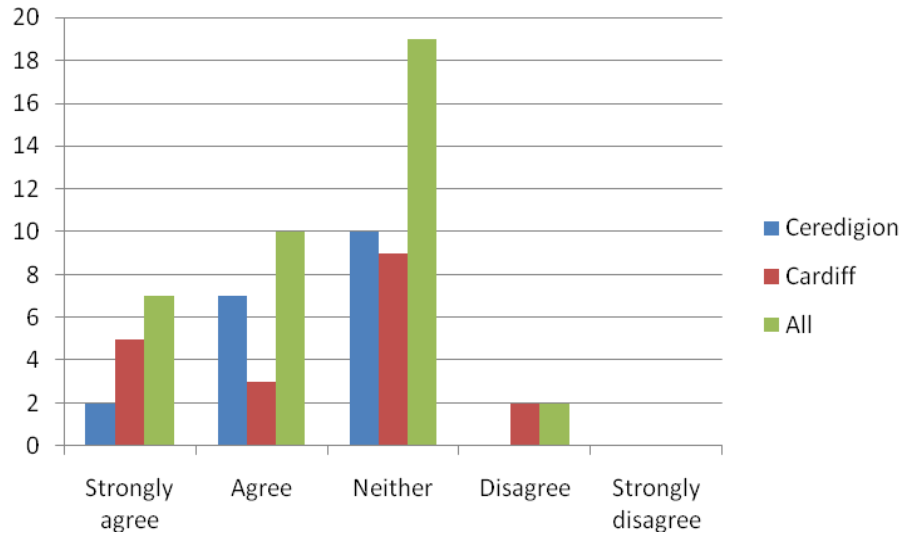

Figure F.25 – Improved product design

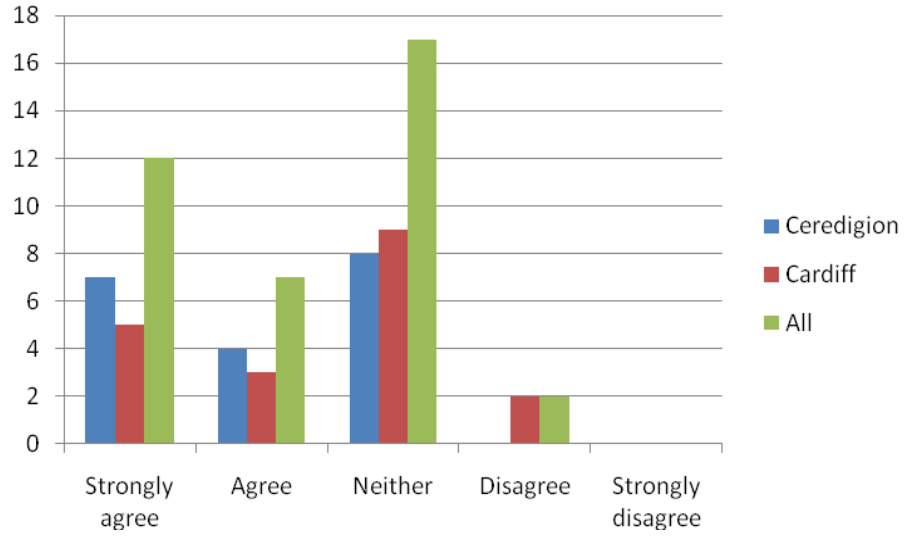

Figure F.26 – Higher customer retention

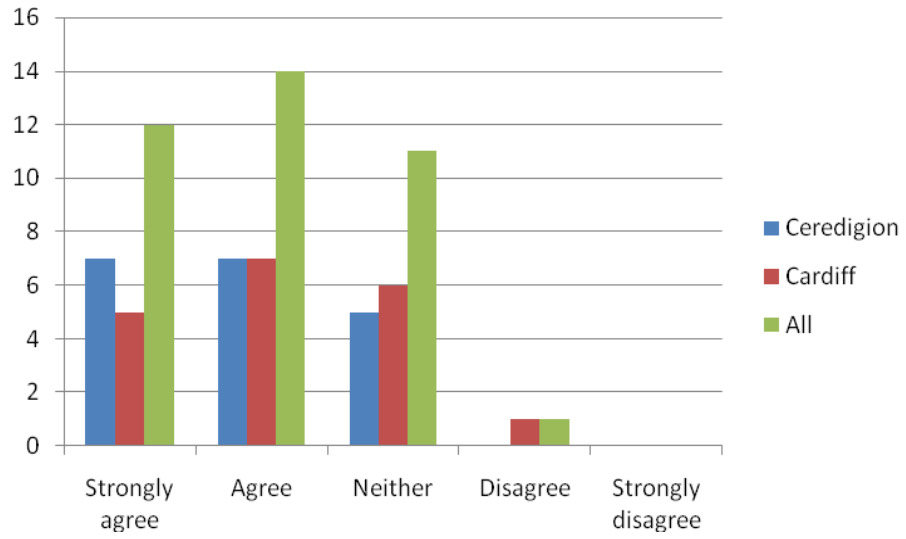

Figure F.27 – New business opportunities

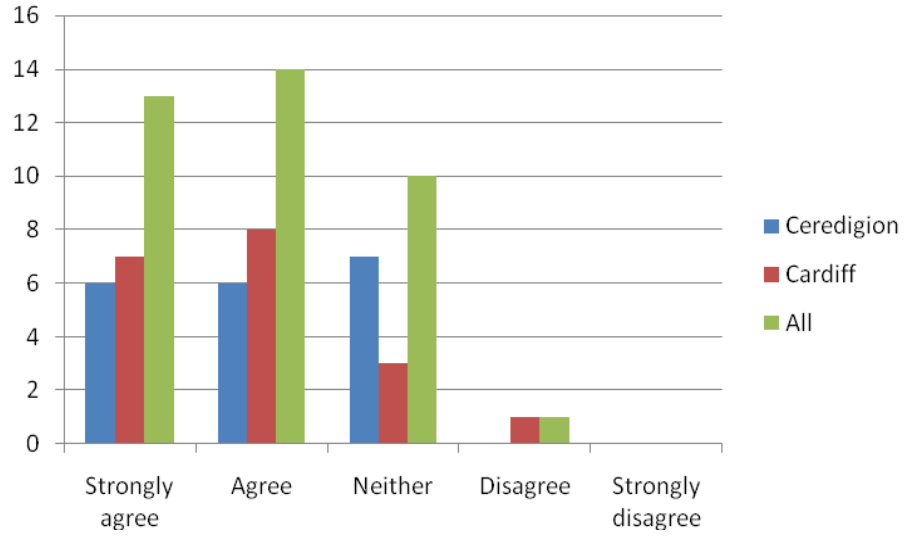

Figure F.28 – More efficient internal operations

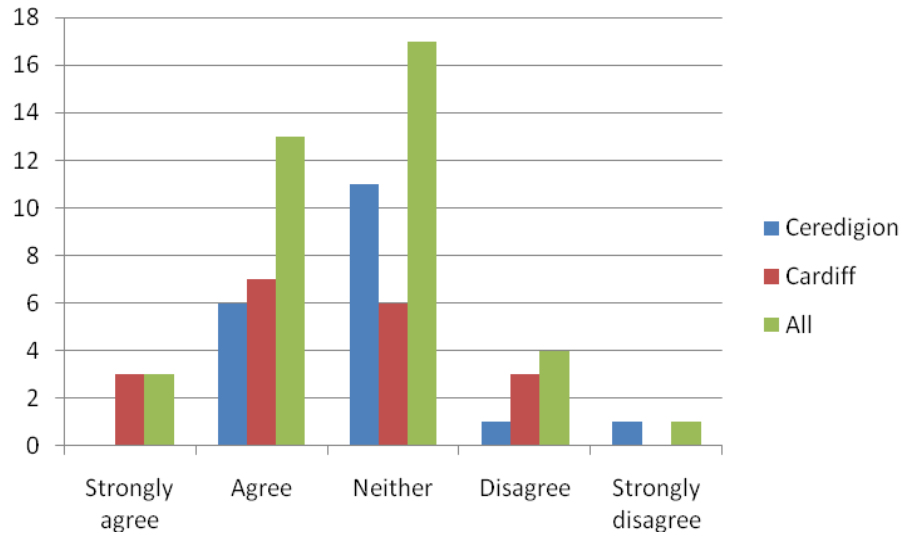

Figure F.29 – Higher skilled workforce

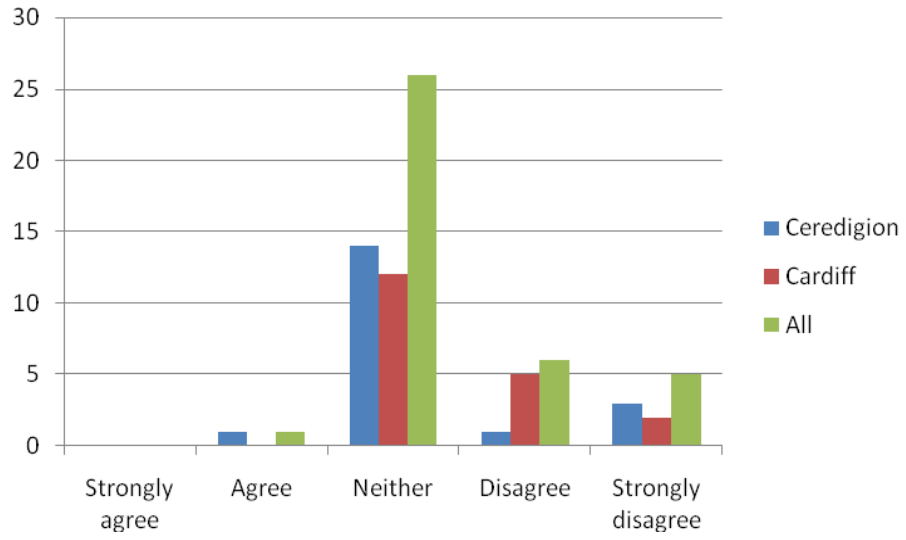

Figure F.30 – None

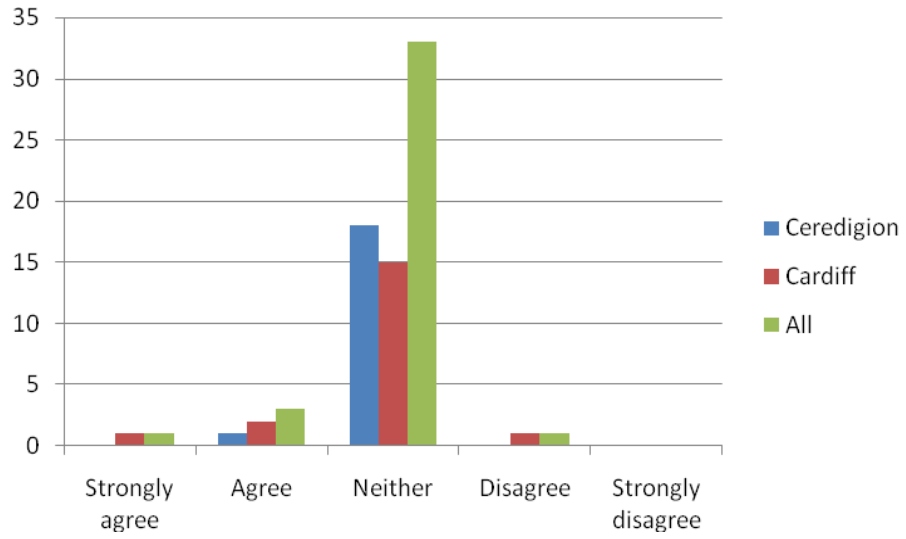

Figure F.31 – Other

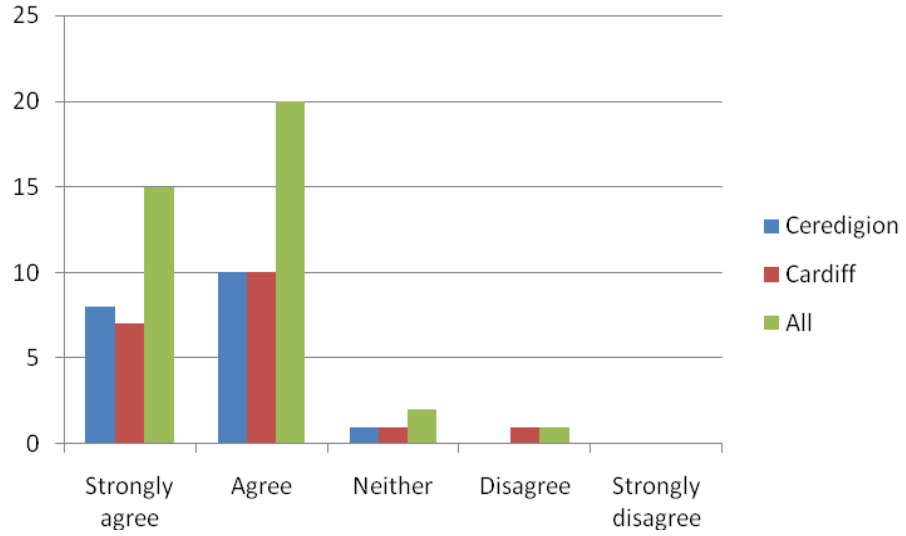

Figure F.32 – Cost savings (future)

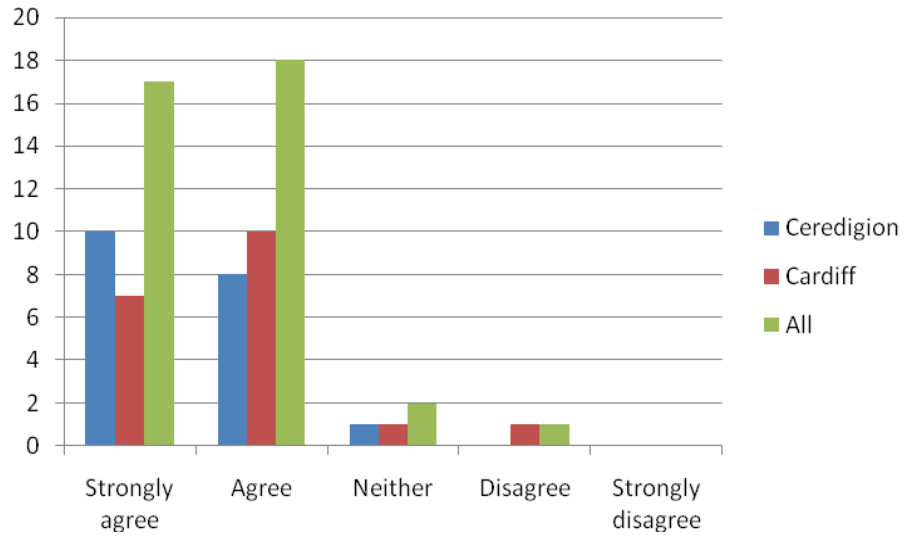

Figure F.33 – Time savings (future)

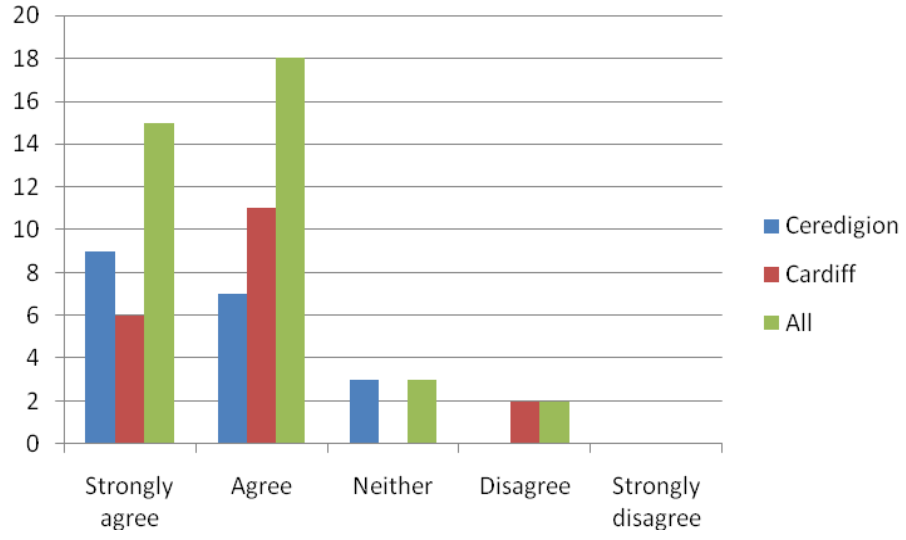

Figure F.34 – Increased customer satisfaction (future)

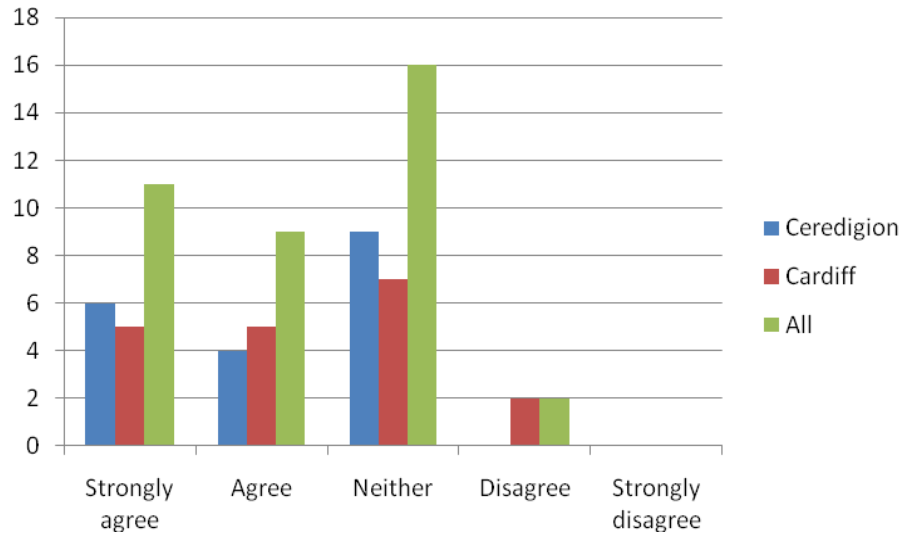

Figure F.35 – Improved product design (future)

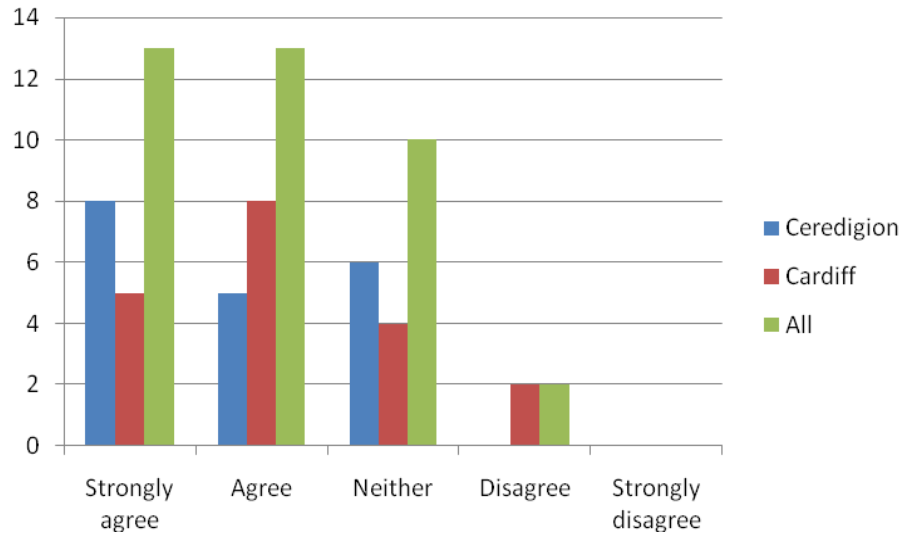

Figure F.36 – Higher customer retention (future)

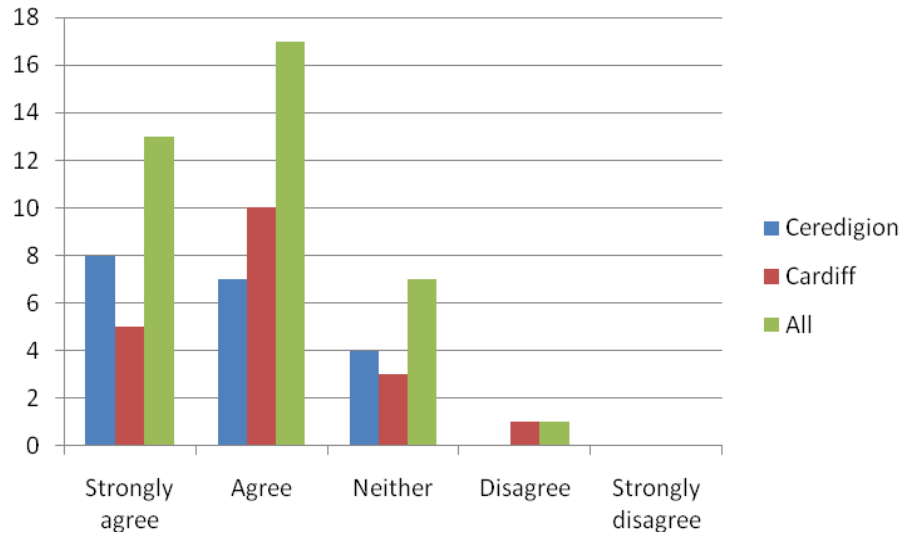

Figure F.37 – New business opportunities (future)

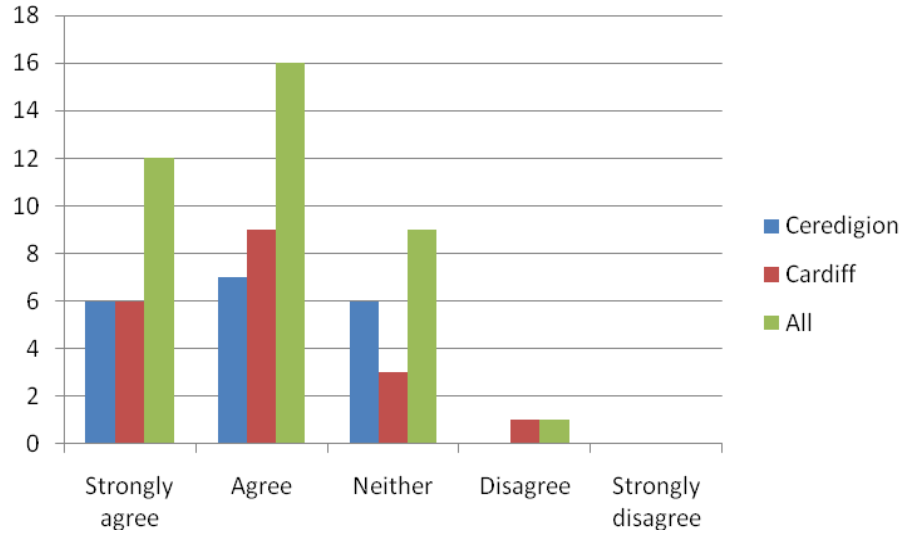

Figure F.38 – More efficient internal operations (future)

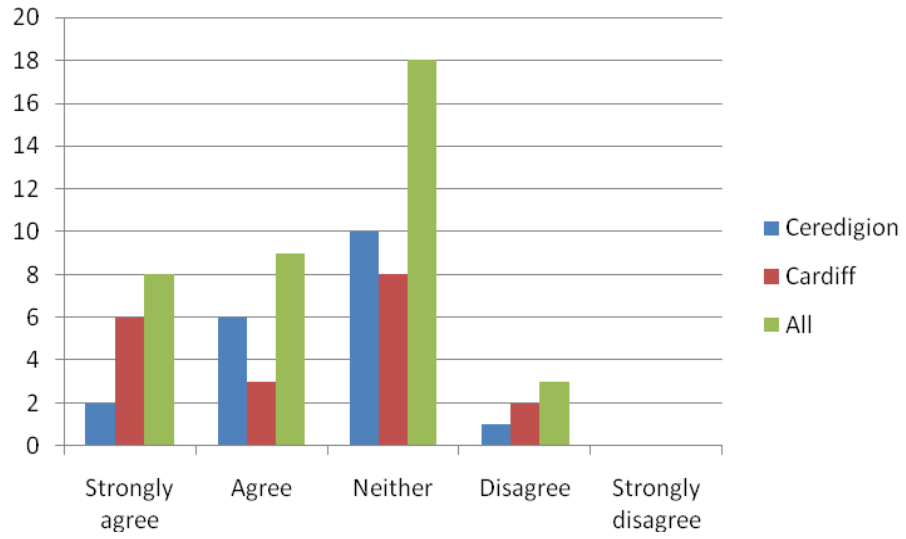

Figure F.39 – Higher skilled workforce (future)

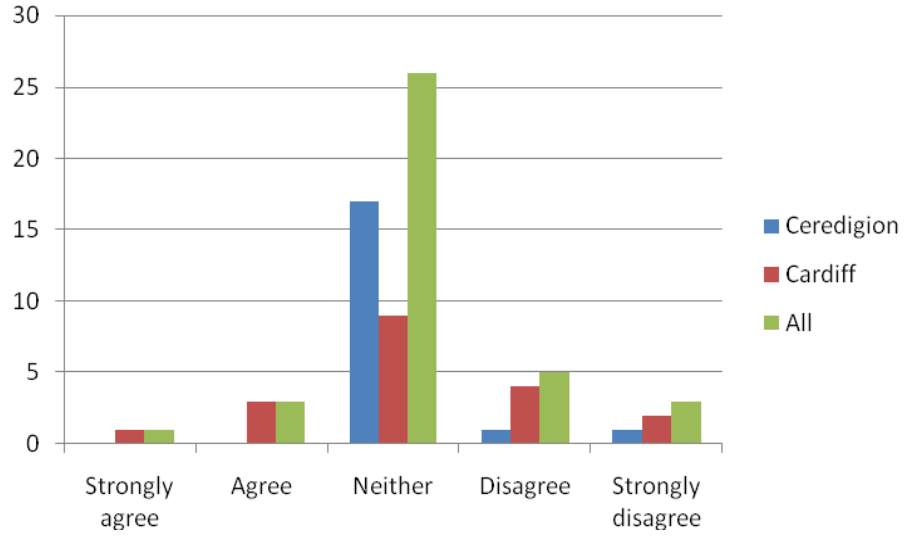

Figure F.40 – None(future)

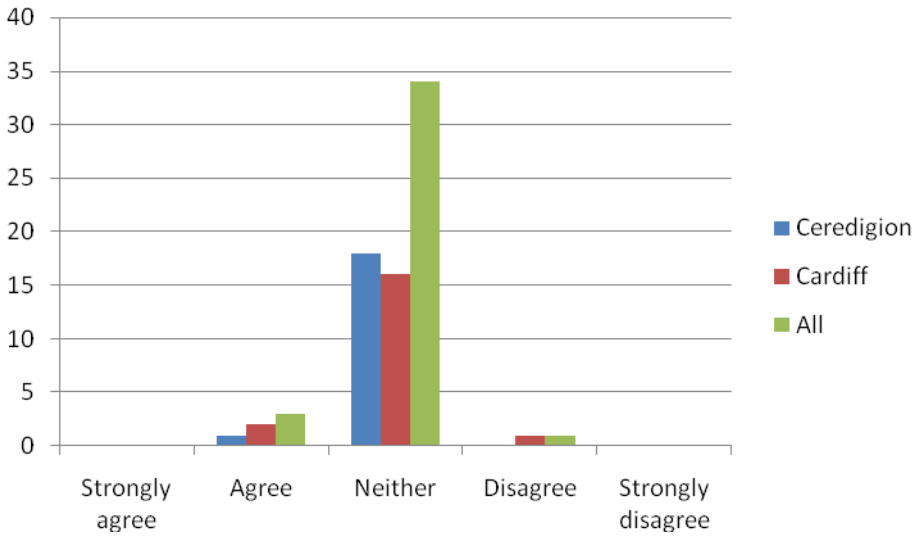

Figure F.41 – Other (future)

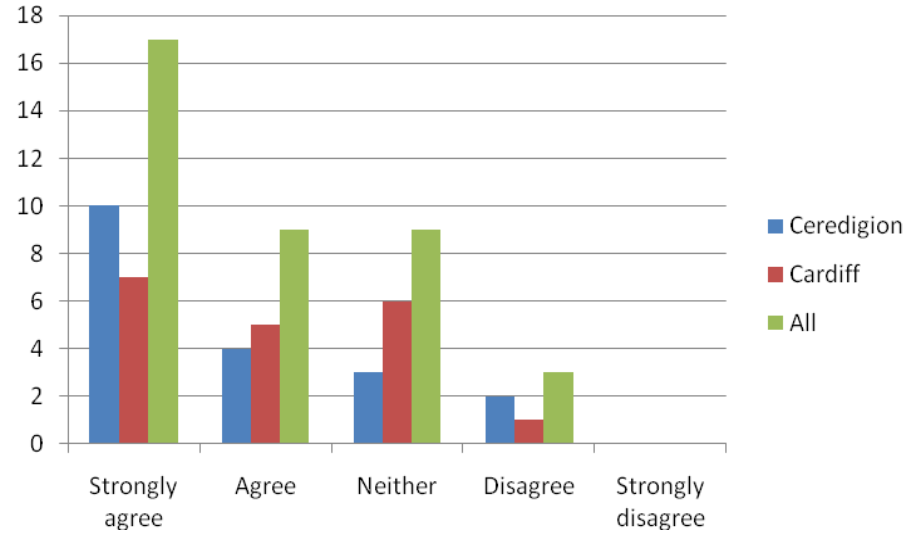

Figure F.42 – Productivity

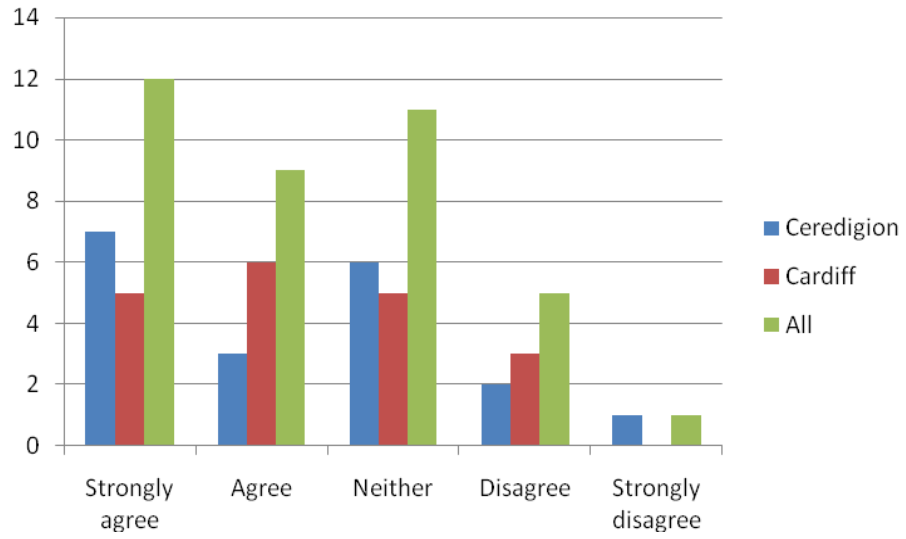

Figure F.43 – Turnover

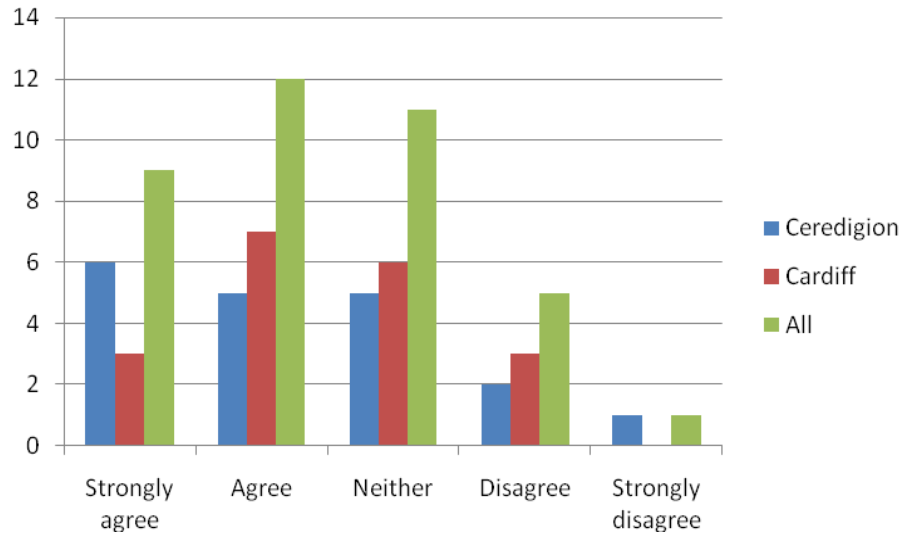

Figure F.44 – Profit

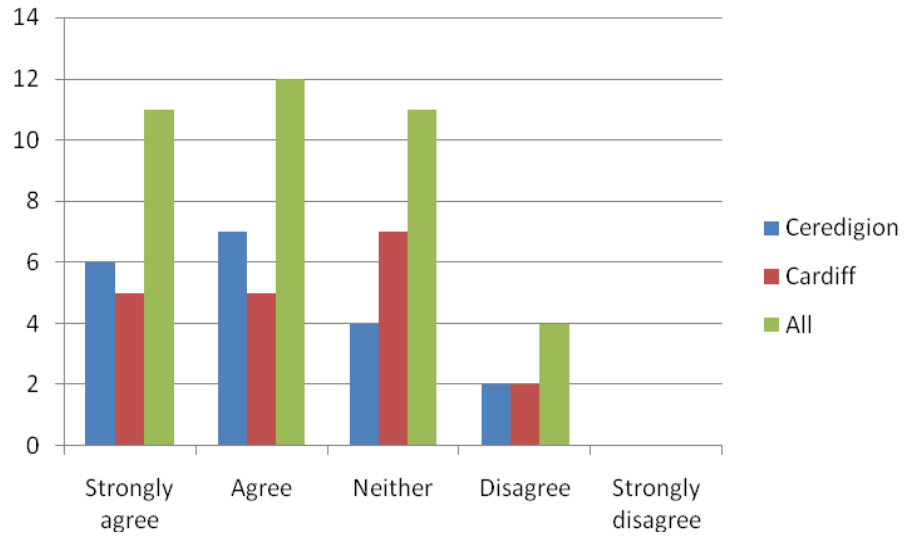

Figure F.45 – Target marketplace

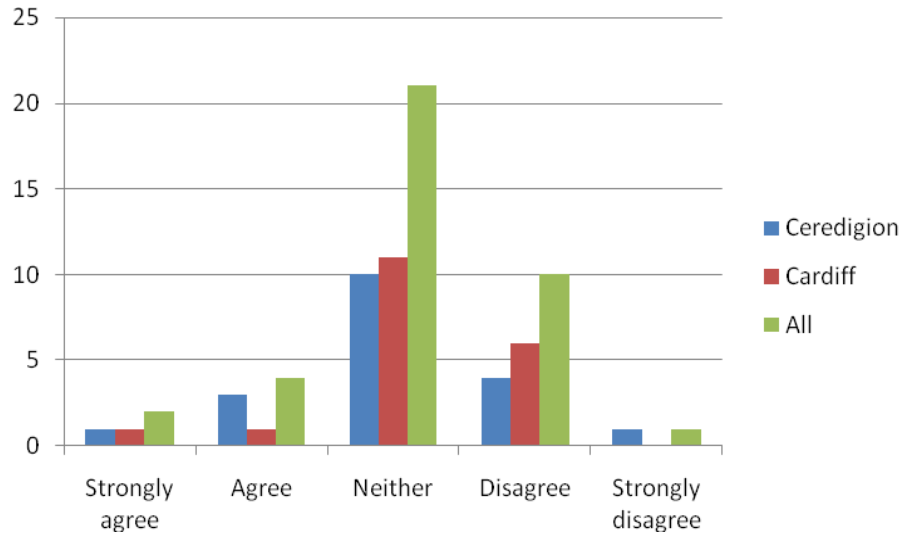

Figure F.46 – Number of employees

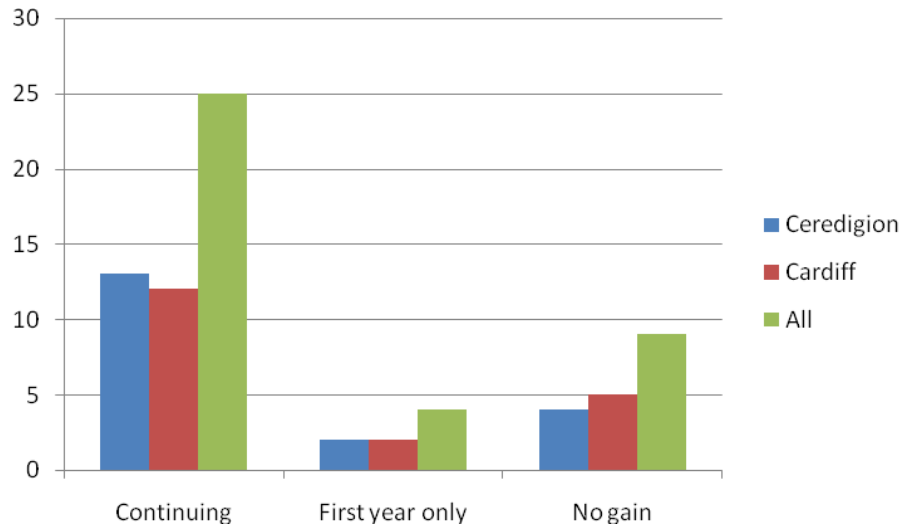

Figure F.47 – Productivity

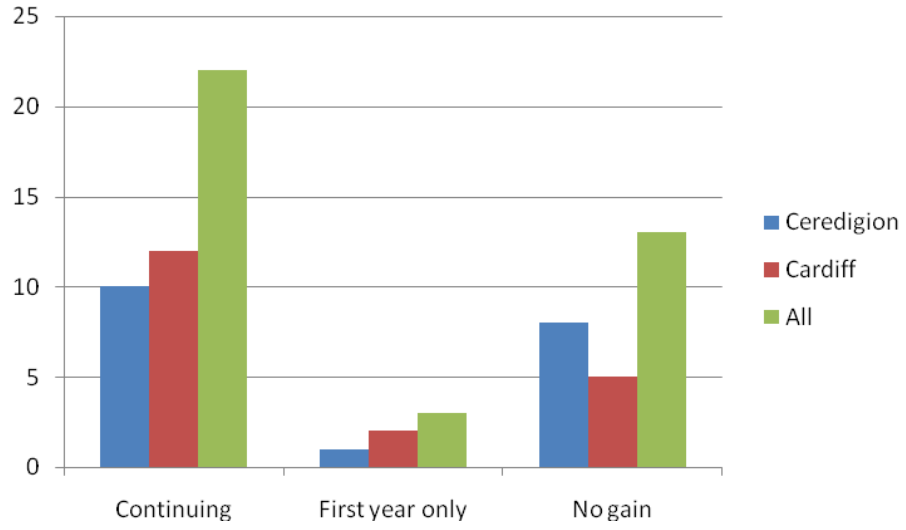

Figure F.48 – Turnover

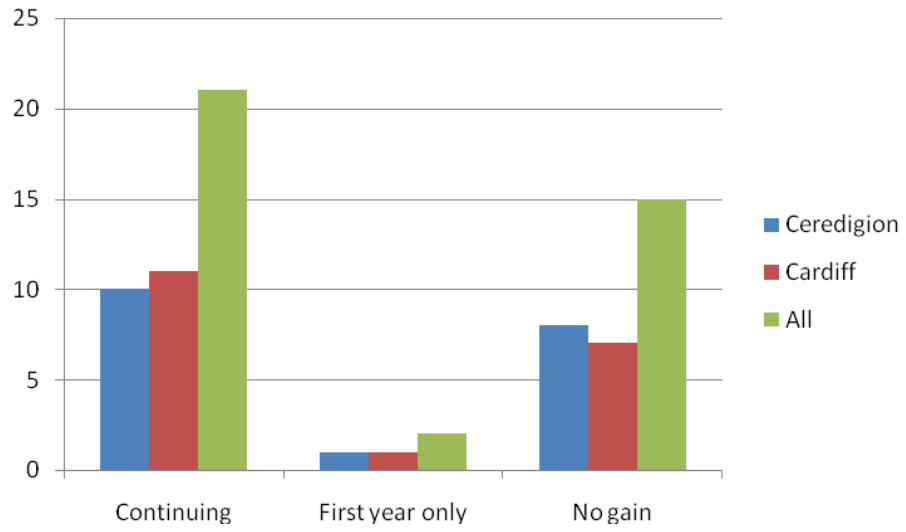

Figure F.49 – Profit

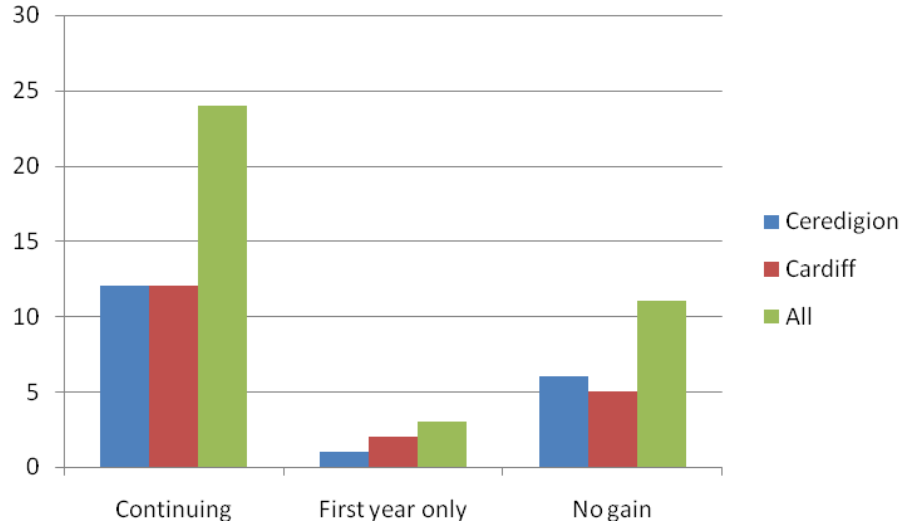

Figure F.50 – Target marketplace

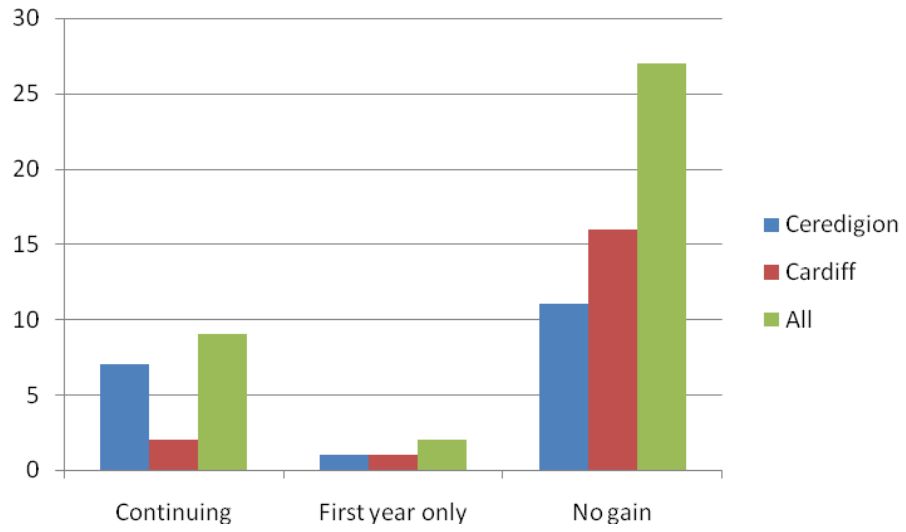

Figure F.51 – Number of employees

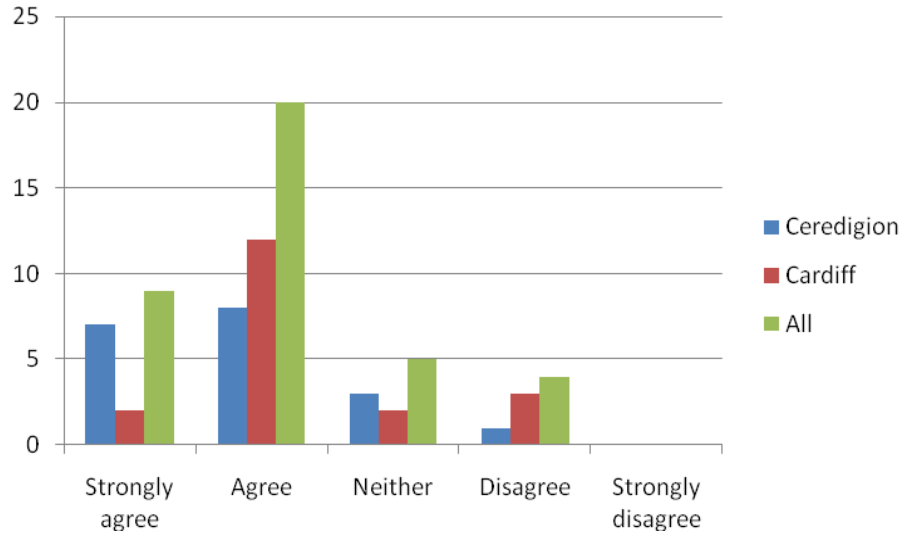

Figure F.52 – Skills and knowledge

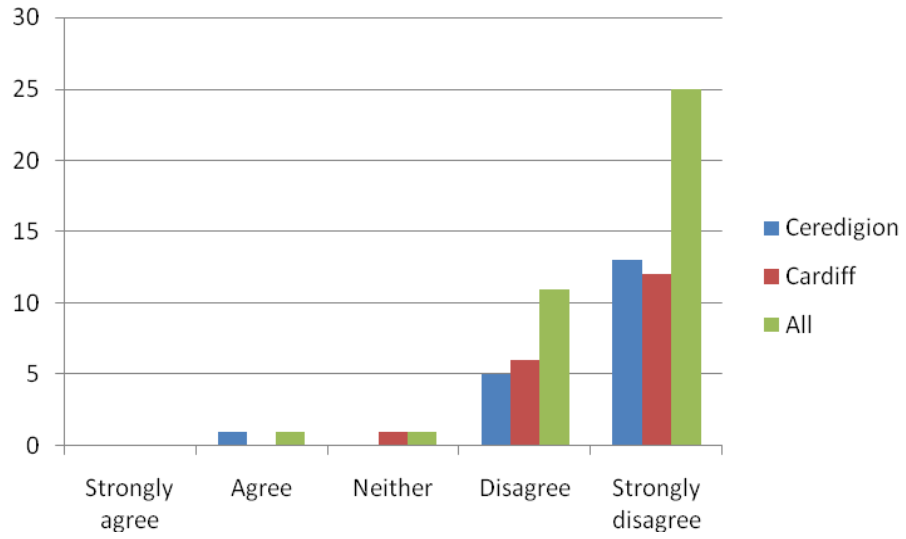

Figure F.53 – Could businesses continue to operate without broadband?

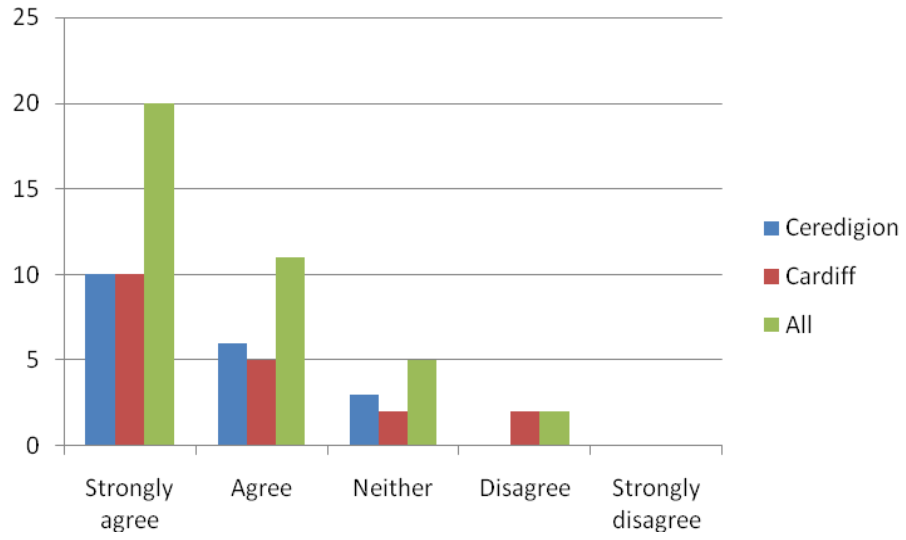

Figure F.54 – Operate better with improved connection

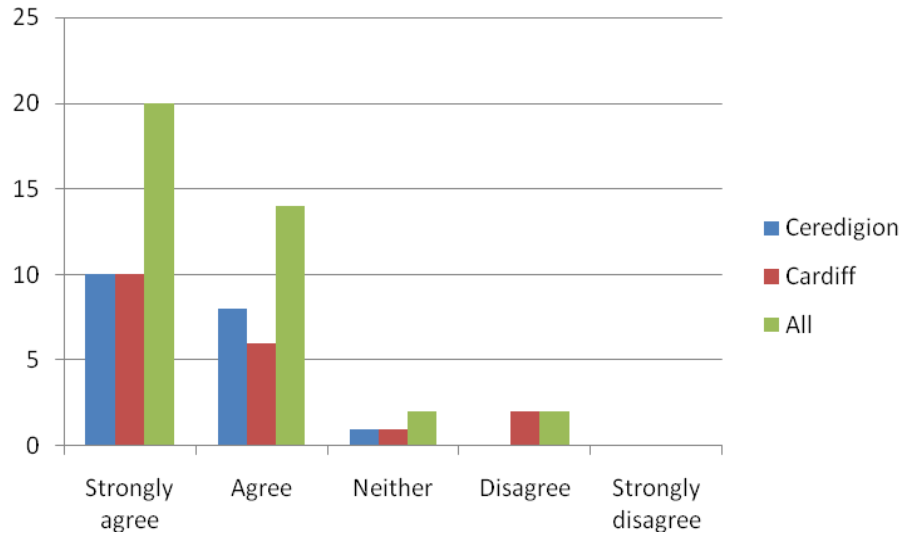

Figure F.55 – Download speed

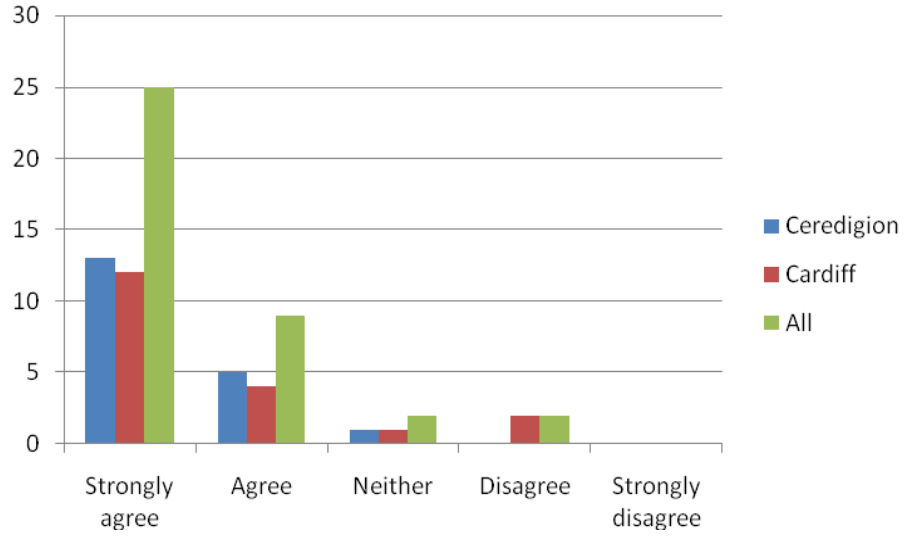

Figure F.56 – Upload speed

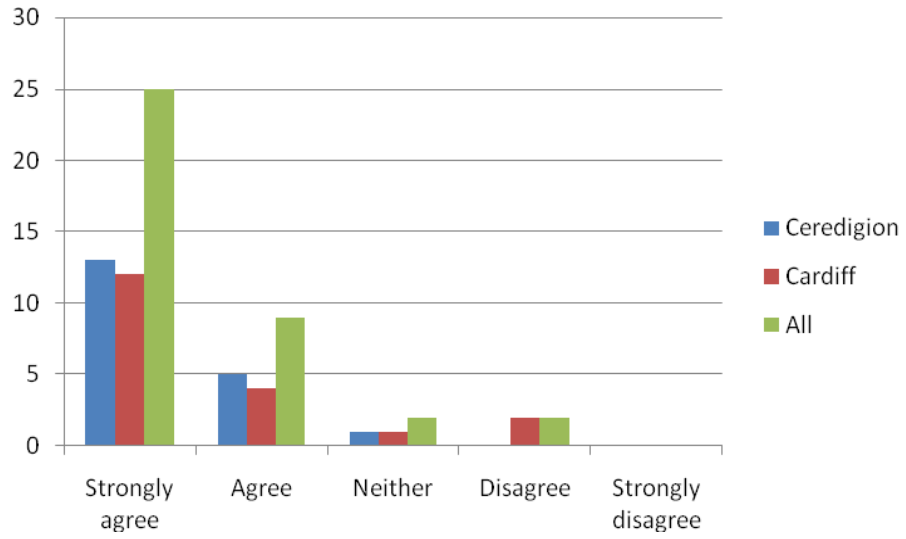

Figure F.57 – Reliability

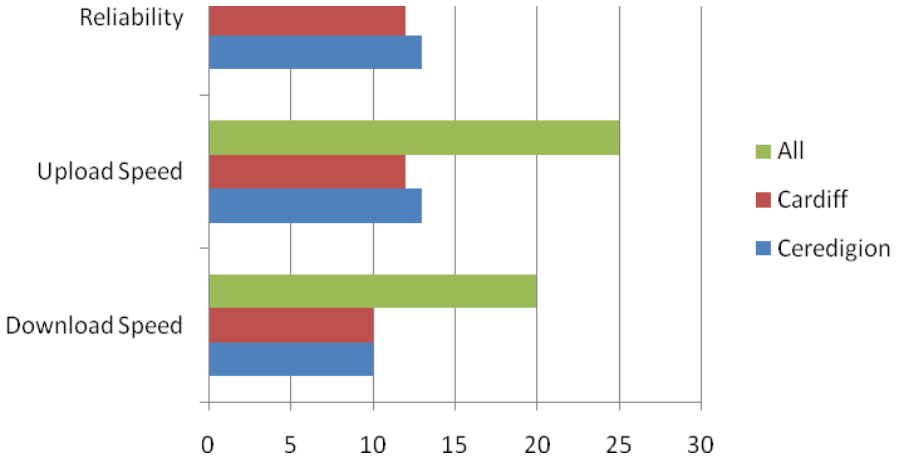

Figure F.58 – Strongly agree to need for improvement in broadband components

Appendix G: Relationships

SME Questionnaire (Appendix B)	Analysis (Chapter 6)	Figures (Appendix G)
Q3	Table 6.1	-
Q4	Table 6.2	-
Q5	Table 6.3	-
Q6	Figure 6.1	-
Q7	Section 6.2.1.2	-
Q8	Table 6.10	Figure G.1
Q9	Table 6.4	Figures G.2 – G.10
Q10	Table 6.5	Figures G.11 – G.21
Q11a	Table 6.6	Figures G.22 – G.31
Q11b	Table 6.7	Figures G.32 – G.41
Q12	Table 6.8	Figures G.42 – G.46
Q13	Table 6.9	Figures G.47 – G.51
Q14	Table 6.14	Figure G.52
Q15	Table 6.10	Figure G.53
Q16	Table 6.10	Figure G.54
Q17	Table 6.11	Figures G.55 – G.58

Appendix H: Profile of Panel Experts

Expert 1 - Analyst at a Broadband consultancy firm
Expert 2- Member of Community Broadband Network assisting SMEs realise the benefits of Next Gen Broadband
Expert 3 - Director Public Sector, BT Wholesale
Expert 4 - Deputy Secretary General, Association of European Chambers of Commerce and Industry
Expert 5 - Former software engineer, BT
Expert 6 - Former software engineer, BT
Expert 7 - Financial Controller Farmers Union of Wales
Expert 8 - Former Ofcom Board member
Expert 9 - eBusiness Unit, Department of Enterprise, Trade and Employment, Government of Ireland
Expert 10 - Professor of eBusiness
Expert 11 - Past Non-Exec Director OFCOM