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Research and Development Best Practice in SME's Sector

Northern Ireland's economy is predominantly based on Small and Medium size enterprises (SMEs). This research briefing looks at the structural factors affecting research and development (R&D) within the SMEs sector in Northern Ireland. Northern Finland, Southern Sweden, Queensland, Japan, and Taiwan were used as comparator regions to identify the key success factors that could be exploited by Northern Ireland to promote Research and Development.

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INTRODUCTION

In Northern Ireland there are estimated to be 84,620 small and medium sized enterprises (SMEs), employing 425,000people[1].

Globally, it is recognized that approximately 80 percent of economic growth comes from the SMEs sector[2]. In order to clarify the strategic role that SMEs play in global economies it is important to define what is meant by an SME.

The definition of a small firm varies from country to country. EUROSTAT distinguish three types of small business: micro-enterprises with 1-9 employees, small enterprises with 10-99 employees and medium enterprises with 100-499 employees.

It is easier perhaps to describe the characteristics of an SME than to define the term. Some common characteristics include[3]:

- Independent ownership and management
- Most decision-making functions in small firms rest with the owner/manager
- Organizational structure in SMEs in organic compared to a more bureaucratic structure in large firms
- Limited resource
- A close and loyal work team
- Lack of control over the business environment
- Reluctance to take risk
- Intrusion of family interests

Leavy (1998)[4] reiterates that SMEs are also characterized by an absence of standardization and formal working relationship, they usually have a flat organizational structure, and staff development is limited. These characteristics make SMEs more flexible to environmental changes and research has found that small firms are perceived as being significantly more adaptable than large firms.

THE BENEFIT FROM R&D

R&D plays an important role in the innovation process. It results in the technology that brings new products and services to the market place or underpins better processes. Innovation results in high quality jobs, successful businesses, better goods and services and more efficient processes. For example: R&D can increase product/process innovation that gives a company a competitive edge in the market. A company that consistently under-invests in R&D relative to its best competitors will find that its products are relatively less attractive to customers and that it is increasingly competing on price in the lowest value added segment of the market.

[1] All the figures from Ruth, Fee, Andrew Erridge and Sean Hennigan “SMEs and government purchasing in Northern Ireland: problems and opportunities”, Journal of European Business Review, Volume 14, number 5, 2002, pp326-334.
[2] Jutla, D 2002 Supporting the E-Business readiness of small and medium-sized enterprises: approaches and metrics. Internet research: Electronic networking applications and policy, 12(2), pp139-164.
[3] Source from “General characteristics of the SME sector and the position of SMEs in the serbian economic structure” http://www.sme.sr.gov.yu/AnnualReport2002_2.pdf.
[4] Leavy, M (1998) SMEs flexibility and the role of information system. Small business economics, 11(2), pp183-196.

A company that invests in R&D wisely and at a level at least that fits best competitors, on the other hand, is much more likely to gain customers and maintain or increase its value added.

R&D is also an important driver for organic growth. Most companies have a growth target and, given that major acquisitions are associated with reduced shareholder returns in some two thirds of cases, organic growth through R&D coupled with small bolt on acquisitions of R&D active companies is the preferred route to meet these growth targets.

R&D IN NORTHERN IRELAND[5]

NORTHERN IRELAND R&D EXPENDITURE 2005[6]

Total expenditure on Research and Development in Northern Ireland was £302.4 million in 2005, of which £142.6 million (47.2%) was spent by businesses, £146.2 million (48.3%) by the Higher Education sector and the remainder (£13.6m) was other Government expenditure.

There was a rise of £29.7 million (10.9%) in cash terms and a rise of £24.5 million (8.8%) in real terms in Northern Ireland total R&D expenditure between 2004 and 2005 (from £277.9m to £302.4m).

For the third consecutive year in 2005 Northern Ireland Higher Education accounted for a greater share of total R&D expenditure (48.3%) than the Business sector (47.2%).

Northern Ireland Business, Higher Education and other Government R&D expenditure rose in real terms, by £15.9 million (12.6%), £7.6 million (5.4%) and £1.0 million (8.2%) respectively.

In cash terms total business R&D expenditure in 2005 was £142.6 million, up £18.3 million (14.7%) on the previous year.

Within company expenditure (intramural), a subset of business R&D expenditure, increased by 17.8% in cash terms in Northern Ireland from £115.5 million to £136.1 million. Such spending in the UK increased by 4.6%.

There was an increase (6.6%) in R&D expenditure by the Manufacturing sector from £82.8 million in 2004 to £88.3 million in 2005. A larger increase occurred in the Services and Other sector with R&D expenditure increasing by 30.8% from £41.5 million to £54.3 million in the same period.

R&D ACTIVITY IN NORTHERN IRELAND

The overall picture of business R&D activity within Northern Ireland is one of niche strengths against a background of overall weakness and concern about the future. There are some industries-notably defence and food, where Northern Ireland plays a significant international role.

[5] Source from DETI R&D Report.
[6] Source from Department of Enterprise, Trade and Investment, Northern Ireland Research and Development Statistics 2005, published 24th November 2006.

Higher Education also has a very important role in overall levels of R&D activity. However regional increase in R&D activity over recent years has not matched other regions within the UK.

Although there has been some industrial diversification that has occurred during regional regeneration, comparisons show Northern Ireland to have the most specialist economy within the UK[7]. The economy has some strong regional clusters including aerospace, agriculture and food and textiles. There are also a number of emerging clusters that include biotechnology, technical textiles and software development.

However, a significant proportion of regional employment is within industries that do not form part of there recognized clusters.

The regional economy is characterized as SME-dominated, with large companies representing only 6 percent of the total number performing R&D. These contribute nearly half of total regional R&D, although SMEs play a proportionately more significant part in R&D than is typical elsewhere in the UK. Key contributors within the region include Moy Park, Seagate, Nortel Networks, Bombardier Aerospace, Thales Air Defense, Wrightbus, Ulster Carper Mills and Shrader Electronics[8].

The public sector has an unusually large role within the region, which includes significant numbers of primary and secondary schools and Higher Education Institutions. The region is served by two Universities with a number of academic departments that were recognized by the 2001 Research Assessment Exercise as centres of excellence at the highest levels. Levels of collaborative research income for the regional universities far exceed that for any other region within the UK. This correlates with the high number of firms assisted through consultancy services.

Northern Ireland was felt by DETI to have strong skills bases in electrical, electronic, mechanical and aeronautical engineering that were supported by high-calibre academic departments within the regional universities, this skills base supports the R&D programmes currently undertaken by the large regional companies.

NI GOVERNMENT SUPPORT PROGRAMMES[9]

The Northern Ireland government has a wide-ranging programme of support for R&D which is organized into five different categories as below:

I. Near Market Product and Process Development

This area of support focuses on helping businesses with research and development that will result in a marketable product. This programme is designed to help business to reach its customers as soon as possible. Various experts and specialists, and an extensive range of equipment and facilities can be deployed to help business achieve the goal.

[7] Source from DETI R&D report
[8] Source from DETI R&D expenditure in NI 2005.
[9] Source from Invest NI website

There are seven programmes under this category.

- CE marketing: A programme to help manufacturing businesses gets easier access to European markets.
- Compete: Support to help the business commercially exploit innovative, market-led products and manufacturing processes.
- Product and process development: A programme to help businesses develop innovative new products and processes.
- SMART: The SMART programme encourages research and development investment and the stimulation of new products, processes and technologies.
- EU framework: Support for research, technological development and demonstration activities in the European Community.
- Innovation service: A programme helping business to identify innovation, and use it to create ideas for new or improved products, services or processes.
- Design development: A programme to show the business how design knowledge, skills and capability can help deliver business growth and competitive advantage.

II. Industrial Research

This area of support focuses on helping businesses to research for new knowledge that will ultimately lead to the development or improvement of products or services. The industrial relevant R&D activities help businesses to aim at the acquisition of new knowledge with the objective of using it to develop new products, processes or services or in bringing about significant improvements in existing products, processes or services. There are two programmes under this category.

- Start: A programme to stimulate and increase the level of sustainability of industrially relevant research and development by Northern Ireland based companies.
- Foresight NI: Designed to increase the exploitation of emerging science and technologies with local industry and identify its commercial opportunities, so regions can benefit.

III. Research Infrastructure

This area of support focuses on establishing centres of excellence to stimulate leading edge, commercially focused research that will improve the competitiveness of Northern Ireland industry.

Central to Northern Ireland's research infrastructure are centres of excellence-R&D focused partnerships between government, businesses and the science base. Many of the current number of 18 established centres of excellence in Northern Ireland are working in cutting-edge areas of research, including functional genomics and proteomics, pharmaceuticals and nanotechnology.

These centres of excellence are maximizing the impact of investment in R&D in Northern Ireland and also providing high-tech environments and state-of-the-art equipment, as well as buildings and facilities such as business incubators and best practice showcases.

IV. Knowledge Transfer

This support focuses on developing partnerships that bring together businesses, research bodies and recent graduates to work on mutually beneficial company-based projects. There are six programmes under this category.

- Partnership: A graduate placement programme helping businesses improve competitiveness through better use of knowledge and technology.
- Innovation fund: A programme fostering research, development and technology transfer within academia and assisting universities to increase their capability.
- NI Tech fund: A venture capital fund programme established to finance the commercialization of technology within start-ups or existing businesses and encourage and support R&D.
- Proof of concept: A programme supporting the pre-commercialization of leading edge technologies from local universities and helping researchers export their ideas from the lab to the global marketplace.
- RTD Networking: A programme strengthening Northern Ireland's industrial competitiveness by improving its market-driven and commercially-focused technological research capability.
- Defence Diversification Agency: A programme runs through the Defence Diversification Agency, using expert science and technology teams to find business solutions.

V. Technology Collaboration

Technology collaboration can help forward-thinking businesses and organisations accelerate the pace of innovation and bring competitive advantage to the marketplace. There are two programmes under this category.

- Innovation Relay Centre: Free-of-charge access to Europe-wide technology transfer and collaboration services.
- Business information services: Free-of-charge access to a wealth of business information and commercial intelligence.

INTERNATIONAL COMPARISON

The comparator regions were selected to give a balance of case studies from which Northern Ireland might take examples of good practice. Some were chosen as recognized leaders in developing business R&D, others were chosen as regions which have had low levels of business R&D but have successfully implemented programmes to change this.

NORTHERN FINLAND[10]

Historically the region of Northern Finland has been dominated by hard industry, and has had relatively low levels of expenditure on R&D. However, a tradition of entrepreneurial thinking, originating partly form the region's isolation and peripheral location, together with innovative policies and investment, has transformed the region into a leading region for R&D.

[10] Source from Research and Development Business Expenditure in Northern Ireland, 2004.

PUBLIC RESEARCH FACILITIES AND SPECIALIST SERVICE SUPPORT

The regional governing bodies have provided direct support for the development of R&D in the region through two principal methods: investment to create public research capacity and investment to support intra-regional networking organizations. An important aspect of both these methods of support is that they have been provided across a wide range of sectors, and not restricted to the new knowledge based industries.

The regional government has invested in publicly funded research units which support private sector and University research. There are now several in Qulu, such as the Technical Research Centre of Finland, the Kastelli research centre, which is responsible for national research into the effects of the cold environment, and Centre for Wireless Communications which is ranked among the top 30 mobile technology research units in the world. These facilities provide specialist research facilities and services to companies to support their own research programmes, and provide a good source of basic research. In particular, these specialist services are of use to SMEs, who may not be able to afford to develop their own research facilities.

In addition, the University has three research institutes. Biocenter Qulu promotes basic research into modern bioscience, medicine and biotechnology. Infotech Qulu operates in the field of IT, and Thule Institute operates as an independent national institute for northern and arctic research. Elsewhere, R&D within the Qulu polytechnic supports the development of the service sector and SMEs, acting as a counterbalance to the more academic research occurring in the various research institutes. At the polytechnic, the research is working life driven and vocationally driven, and this enables the education programmes to react flexibly to changes in the skills needs of the business community. They are able to offer specialist courses, tailored to the needs of particular companies and sectors, ensuring that the skills base of the region remains current and fit for purpose.

Policy in the Qulu region has not focused on specifically creating specialist services to support the development of R&D, outside the support provided for public research facilities and networking organizations. Instead, the regional government has placed innovation at the centre of its economic policy, and worked in collaboration with industry and the academic sector to create a climate which allows R&D and innovation to thrive. Specialist services have tended to develop in response to identified needs within particular sectors, often through the forums and other networking organizations detailed below, rather than as part of an overall co-ordinated regional policy.

- Co-operation and networking: co-operation between government, business and the academic sector has been a crucial driving force behind the development of Finland into a leading R&D region.
- International outlook: another factor behind the region's success in developing R&D has been an international, outward-facing approach, looking for networking and partnership opportunities across the rest of Finland and internationally.
- Building on inherent strengths: the region of Northern Finland has had particular success in building on its inherent strengths, and leveraging them to attract inward investment and stimulate growth in R&D (such as the greatest strength - the presence of Nokia)

CASE STUDY: VTT ELECTRONICS-THE TECHNICAL RESEARCH CENTRE OF FINLAND[11]

VTT Technical Research Centre of Finland is a contract research organization involved in many international assignments. The centre employs around 2800 people, of which just fewer than 300 are based in Qulu in VTT Electronics. VTT provides a wide range of technology and applied research services for its clients: those in private companies, institutions and the public sector who utilize electronics technologies in their business. The main focus is to create new technologies and visions to assist clients in developing new products and technology solutions, and their work is based on close co-operation with clients and research institutions all over the world. This ensures VTT remains on the cutting edge of the sector, and in turn ensures companies in the Qulu region have access to up to date information on new developments in the sector. VTT's R&D activities broadly cover the innovation chain from strategic basic research, through applied research, right through to product development and testing services supporting it.

VTT is an integral part of Finland's innovation system. In addition to contract research for companies, VTT also promotes technology transfer by producing a great deal of public research knowledge and by actively participating in both domestic and international research programmes and collaboration networks. VTT envisions future technological development and focuses its resources on new, promising and techno-scientifically challenging technologies that are expected to offer new opportunities for the Finish economy.

The effects of VTT's activities are felt through research, development and test results leading to new technical innovations. By creating new technical solutions VTT helps companies to improve their competitiveness.

The results of collaboration with companies include improvements in their products, equipment, production methods and processes. VTT also promotes social well-being by producing research knowledge in support of decision-making in areas such as human health, the built and natural environment, and the use of natural resource. The support for companies in Qulu which results from the location of VTT Electronic there is an important factor in the region's R&D strength.

SUCCESSES AND FAILURES: LEARNING POINT ENCOUNTERED

A potential barrier to the development of northern Finland is its relative isolation, and distance from the major economic centers of Europe. To minimize the impact of this there has been consistent investment in transport infrastructure, and Oulu has developed into an important logistical centre for the region. Oulu has Finland's second busiest airport, a deep channel harbour which is open year round, one of Finland's main railway stations and the city is a meeting point of several highways. This development has been part of a wider strategy to make Qulu a crucial node in the Northern European transport network, linking the EU to NW Russia; the city is linked directly to the NW Russia rail network, a high-speed rail link has been opened to Helsinki, and there are direct sea freight services to central Europe. There are also plans for an integrated road, rail and sea freight terminal.

[11] Source from http://www.vtt.fi/indexe.htm

SOUTH SWEDEN-SYDSVERIGE[12]

South Sweden has historically been good at basic research, but suffered from a limited capacity to commercialize the research which was occurring, despite the presence of the University of Lund, the largest institute for research and higher education in Scandinavia. The transformation of the region into a leading R&D region has been based on a combination of innovative policies and building on the region's existing strengths. The ways in which the transformation has been achieved are discussed as follows:

- Networking: the ability to collaborate and develop networks and clusters, within the region as well as with foreign partners, has made Southern Sweden one of the strongest growth regions in Northern Europe.
- Links between University and industry: the region is strong at basic research, but historically has not been good at converting that into commercial returns through partnerships with industry. There are a large number of research and technology parks in southern Sweden, and there have been the targets for improving the level of commercialization.
- Internationalization: in recent years there has been an increasingly pronounced trend towards internationalization of universities and colleges in Southern Sweden, especially in the direction of Denmark after the opening of the Qresund Bridge.
- Availability of qualified staff: a strength of the region, which is particularly valued by large companies located there, is the availability of qualified staff.
- Funding for innovative start-ups: while Government initiatives have focused on building excellence at the basic research level, this has not been at the expense of ensuring that there is funding available for innovative companies at all stages of growth.
- Encouraging innovation in SMEs: there has been significant growth in the new knowledge-based industries, there remains a significant proportion of the region's economic base which is in SMEs in traditional industries, including some within the food production sector as well as lots of small mechanical and wood manufacturing workshop. There has been the particular target of programmes to increase innovation, as without innovation and growth they will be unable to compete in future. Regional policy has focused on providing specialist services, advice and support to there companies, as obtaining such services for themselves can be prohibitively expensive.
- The region has targeted the SMEs in two ways: the first one is that Region Skane is aiming to improve specific competencies within these companies by linking them to the Universities and harnessing their expertise. The second way is the University of Lund has set up a company to encourage technology, which is now partly funded by Region Skane. The company aims to bring new technology and processes into local SMEs. It develops direct links with local SMEs, especially those from the traditional industries, and helps them to improve efficiency and cost-effectiveness of what they do by improving their processes and techniques.

[12] Source from A comparison with the UK and other International Regions, R&D Business Expenditure in Northern Ireland, 2004.

SUCCESSES AND FAILURES: LEARNING POINTS ENCOUNTERED

The region has encountered a number of problems in the development of R&D, which have been dealt with in innovative ways. One of the earliest was a complaint from the companies that they did not understand the roles and responsibilities of the different intermediary and support organizations, and they did not know the services they offered. This has been addressed through some reorganization of roles, but mainly greater contact and networking between the support organizations, so that they can offer an integrated service. Each organization is clear about its role and the roles of its counterparts, and there is now a clear model for companies to follow to receive different types of assistance.

Another problem had been a lack of co-ordination between the research councils, and an inability for them to act at the speed demanded by the market. This is now being looked at, and as a first step, the four separate research councils with four branches, called the Swedish Research Council were established. There are also sector specific developments proposed. For example, because of the fast development of the biotechnology sector, it has been proposed that a special governmental agency for inspection of biotechnology should be started. The agency would investigate all new activities in biotechnology and not specialize in any other field of research. Another agency for technological evaluation has been suggested because of the general complexity of the science and the information and stimulating discussions about the subject. More importantly, this agency would be involved in transferring information regarding different technologies to the politicians and aiding in their decision-making processes[13].

The business culture has also been a limiting factor. Culturally the people of the region tend to think like scientists and researchers, and they lack entrepreneurial skills. This also have an impact aspirationally, as many of the best students aspire to join the large prestigious companies in the region, rather than set up their own innovative company. To help to change this, the region has introduced several programmes to encourage entrepreneurship. An ectrepreneurial element is being added to the school curriculum from age 6-the idea is that entrepreneurship will form an integral part of their education and this will help to develop entrepreneurial spirit and culture in the business community[14].

QUEENSLAND[15]

Queensland has historically been a prosperous state, though the State economy is relatively shallow, being largely based on mining, sugar, tourism and agriculture. Recent government policy initiatives, under the Smart State programme, have aimed to broaden the economic base, increase the productivity of Queensland's workers, and commercialize more of the basic research going on in the state.

[13] Source from Bioseeker Group Swedish Agency for Innovation Systems: 2002. Swedish Biotechnology. http://www.vinnova.se/upload/EPiStorePDF/va-03-02.pdf

[14] Source from Junior Achievement Young Enterprise Europe Annual Report 2006, "Entrepreneurs are made, not born". http://www.jaye.org/Main/Default.aspx?Template=TProjects.ascx&phContent=ProjectShow.ascx&CatID=32&ArtID=385&LngID=0

[15] Source from A comparison with the UK and other International Regions, R&D Business Expenditure in Northern Ireland, 2004.

The expansion in business expenditure on R&D was brought about by a coherent policy implemented by the state to encourage R&D across all sectors, and rapid development of the biotech and ICT sectors. The Smart State Strategic Plan was born partly out of a perception that Queensland's economy was behind the curve. It was not a progressive economy, and political conservatism combined with the shallow economy was limiting growth and development. The public sector has historically played a leading role-with business leaders to take that role.

The Smart State policy aimed to change the perception of Queensland as a backward economy, and there has been real and significant investment to develop the IT and biotech/life sciences sectors.

The key elements of the Smart State Policy as following:

Government leadership and state investment: one problem identified within Queensland was a lack of leadership in innovation and R&D from the business community-as mentioned earlier this is often attributed to the SMEs based economy and a lack of large innovative companies and hence a lack of business leaders. In the absence of clear leadership from business, the Queensland government has taken on this role itself, demonstrating a strong commitment to science and innovation and the development of knowledge based industries. The government has developed a detailed R&D strategy, and vigorously driven strategies to establish Queensland as Australia's Smart State, with the aim of developing Queensland as an Asia-Pacific hub for new knowledge based industries. The government has led by example and demonstrated its commitment with large scale investment in science, research and innovation, including infrastructure investments. This investment has been aimed both at creating economic growth in emerging industries and also industries, such as mining, manufacturing, construction and farming, to ensure that they remain competitive in the world marketplace, as part of the investments the government is encouraging businesses to adopt high tech solutions-using world class, cutting edge approaches.

- The appointment of a Chief Scientist: Queensland now has one single person responsible for driving the development of R&D and innovation in the state within the new knowledge-based industries, the Queensland Chief Scientist. The role of the Chief Scientist is to develop new partnerships with researchers and industry, and attract more investment in Queensland science, research and education. In addition, they will report annually on how Queensland's performance in science and technology compares with world advice on the development of R&D in these industries in the state. The position will complement an already successful counterpart position-the Department of Primary Industries' Chief Scientist which has been very successful in developing the primary industries in the state.
- Research infrastructure: the Queensland Government's investment in R&D infrastructure is one of the central features of its Smart State vision. The government believes there is a need to invest in infrastructure of all types to allow the private sector to excel. Over recent years, significant government funding has been assigned to infrastructure that supports strategic and applied research of major importance to Queensland's economic and social development. The Queensland government has set up a series of schemes to address the low level of commercialization of basic research. Many of these were set up to address funding gaps for entrepreneurs wishing to commercialize basic research, or for small companies needing capital for growth.

- Innovation and commercialization support schemes: Queensland has also set up a number of other strategies to provide specialized non-financial innovation and commercialization support. One strand of this has been a series of programmes to provide the specialist skills, tools and strategies needed by local SMEs and entrepreneurs to commercialize their ideas and grow their business. These include providing information and guidance on the commercialization process through a website and a series of forums and short courses. The forums and short courses provide innovators with opportunities to learn and apply the necessary skills and knowledge to commercialize their ideas.
- Focused development: an important aspect of Queensland's success has been the clarity of the strategy, and the clear focus on specific areas where Queensland can leverage its natural advantages, such as in biotech sector and IT sector and the e-learning industry is developing rapidly as well.
- Building on the region's inherent strengths: Queensland has a number of inherent strengths, which the state government has successful marketed and built upon. Queensland is a low tax state with multiskilled and highly educated workforce supported by world-class tertiary institutions. In addition the State has excellent transport facilities, including high quality air and shipping terminals and good road and rail networks. The standard of living is high, and the sunny climate offers an attractive lifestyle. Together, these factors have helped the Queensland government attract significant inward investment to support the growth of R&D in the state-high-tech companies such as Boeing, Red Hat, GE Medical Systems, Sequenom and Mincom, who have established their Asia-Pacific headquarters in Queensland.

SUCCESSES AND FAILURES: LEARNING POINTS ENCOUNTERED

While Queensland has been extremely successful in encouraging the growth of R&D through the Smart State Strategy, a number of barriers have emerged during implementation.

- Cultural barriers: one difficulty in encouraging innovation has been linked to the lifestyle. While this can be a positive factor in attracting inward investment, it can also have negative implications. The lifestyle can discourage growth, particularly within SMEs-for the people running SMEs growth could mean more work which would impinge on their lifestyle, and there is no real incentive to take risks which could affect their lifestyle. However, this does not have to be a problem. The solution in Queensland has been to encourage the development of an economy which contains all parts of the value chain. Where one company does not want to take on a new role, there must be another company offering that complementary service.
- Australian industry and financiers are conservative in accepting risk in R&D to improve capital equipment and internal processes. Market acceptance in Australia is mainly about having a proven product. The commercial risk associate with developing an Australian alternative to an imported product is deemed too high. In addition, Australian companies have difficulty with collaborative R&D and businesses shy away from investing in areas where they cannot control the outcome and or where positive outcomes from investing in areas where they cannot control the outcome or where positive outcome from the research could benefit their competitors as well. The Cooperative Research Centre program has provided a platform for increased collaboration amongst R&D sectors. This program needs to be developed

further in order to provide a vehicle for business collaboration in R&D, especially amongst SMEs[16].

- Funding Gap: Queensland has also had problems with a gap in the funding cycle. There are now a series of public fund for early stage company development to assist with start-up, proof of concept. But there has always been a lack of the next level of funding to take companies from start-ups to established companies.
- Lack of leading entrepreneurs: the State's poor record of commercializing research, together with conservative lending institutions and a lack of venture capital, mean that there are very few people within Queensland who have commercialized research, set up a successful business and moved on to new ventures. This lack of entrepreneurs who have the experience of commercialization has been a limiting factor in the innovation and entrepreneurship support schemes set up by the government. While the theory of setting up new businesses can be taught, there is really no substitute for experience and the leadership and guidance such experienced entrepreneurs can provide.
- Internal competition: Australia's internal state borders are very strong, to the extent that inhabitants often see themselves as Queensland before they see themselves as Australians. When combined with the power help by the state, this can lead to excessive competition between states. Instead of co-operating, resources are often duplicated which is highly inefficient, and sectors such as the biotech sector do not present a united, national picture to the global market, which limits it impact and pervasiveness.

JAPAN[17]

Japanese SMEs have been playing an important role in the Japanese economy in the latter part of the 1990s. Some of SMEs have definitely become more competitive in an IT economy than before. Through the Internet and web sites, they can easily collect information about market, customers and technology. While prompt decision-making and flexible management are essential for competitive business in an IT economy, SMEs incorporate potential advantages for this business strategy.

The Japanese SMEs have been performing more dynamically than large enterprises. On a macro base, SMEs performance of R&D investment and sales is comparable to large enterprises. The analysis using micro-data based on the Survey of Japanese Business Structure and Activities, which is conducted annually by the Ministry of Economy, Trade and Industry, demonstrates that there are many SMEs achieving excellent performance, especially in manufacturing industry.

Outstanding Japanese SMEs have accumulated their technology potential and developed new business aggressively based on technological innovation utilizing the external technology information, particularly information from large enterprises, universities and government. Here are some examples.

[16] Source from Queensland Government Annual report 2002. http://www.qld.gov.au/
[17] R&D and Innovation in SMEs. Department of Research and Statistics, Ministry of Economy, Trade and Industry, Tokyo.

CASE 1: CHOSHU SANGYO (CIC) - INTEGRATED CIRCUITS (IC) MANUFACTURING EQUIPMENT PRODUCER IN ONODA

CIC was established in 1980 as a manufacturing firm of housing equipment such as boilers and solar systems. CIC endeavored to develop new products in this field using advanced technology. It faced a turning point when NEC constructed an IC factory at its adjacent town in 1985. In this unexpected circumstance, in order to secure some IC relevant business from this NEC factory, CIC contracted a business alliance with a big IC manufacturing equipment producer and seconded six talented engineers out of 60 employees to this allied firm for training. CIC then started to provide a maintenance service to the NEC factory and accumulated the know-how essential for manufacturing IC relevant equipment. On the basis of these consistent efforts, now the IC manufacturing equipment business has grown up to the main business field in CIC with 420 employees.

CASE 2: NAKASHIMA PROPELLER - ARTIFICIAL JOINTS MAKER IN OKAYAMA

Nakashima Propeller was established in 1926 as a manufacture of marine propellers. Based on its expertise it contracted technical agreements with European prominent manufactures of controllable pitch propellers and rudders in the 1970s. Supported by these technical alliances it was able to introduce the most advanced technology and develop its own technological potential. These successive efforts led it to grow up to the world top-level technology possessed firm in the fine fabrication field. Based on its high level of fabrication capabilities and CAD/CAM systems, Nakashima Propeller has grown up to the leading position in the field of propellers in the world with 330 employees. Based on this advanced technological capacity, since the 1980s, it has developed a new competitive field of artificial joints made of titanium alloy for medical treatment in cooperation with several medical university professors.

CASE 3: KATO SEISAKUSHO (KS.J) - AUTOMOBILE PARTS MANUFACTURE IN NAGOYA

Originally, KS.J was founded as a toy-car manufacture in 1946 and then undertook manufacturing of clock parts. It specialized primarily in die making, metal punching, and stamping, plastic molding and unit assemblies. While its business enjoyed success of 10 manufacturing of oil-stove parts and gas equipment & parts. KS.J's President Mr. Kato realized the significance of participating in a new business field where the demand for parts could sustain. Stimulated by the government vision on the prospects of durable consumer goods, he realized the possibilities of the saturation of home equipments and the emergence of cars. Thus, he decided to enter the automotive parts business and endeavored to secure customers of automotive firms with its own identical manufacturing technologies. Now the automobile parts have grown up to become one of the main businesses in KS.J leading to an excellent SME with factories in the US, Korea and Singapore.

LESSONS LEARNED FROM JAPANESE COMPANIES

The foregoing case analyses suggest the following three business strategies supportive to SMEs for their successful business in an information society:

I. Alliance with large enterprises incorporating the advanced technologies

SMEs can assimilate advanced technology through technical alliance with large firms. CIC and Nakashima propeller have pursued this strategy. However, it is generally not easy for SMEs to secure confidence and merit through joint activities with large firms. CIC captured an opportunity of the difficulty of the IC equipment producer due to the huge cost of providing maintenance service by themselves because of the geological distance problem. Generally, SMEs should have a certain level of technology potential needed for technical alliances. Having technical support and collaborative activities with large firms, SMEs can develop their technology capability.

II. Tie-ups with universities

Generally, SMEs have not enough technical staff and may not provide sufficient training opportunities for their engineers. Therefore, the resources of universities are very important to SMEs. They can get technical advice from university professors for their new products development. SMEs may have joint research with universities as universities need the SMEs manufacturing capability for realizing new ideas in universities as Nakashima propeller's artificial joints exactly demonstrated. Most important to be realized is that universities can be the source of new technologies. New knowledge and technology can be created though various challenging researches in universities. Linking with academic research as well as challenging innovations can be conducted by SMEs rather than large firms.

III. Effective utilization of government information

The visions are popularly published by the government to identify future direction of technological development and to develop general consensus among people. Based on these visions, new National R&D projects involving prominent companies are initiated by the government. The trends of markets of emerging new products or technologies as well as the techno-sales situation can be identified by the government visions. As KS.J succeeded, SMEs can elaborate the future technology by making effective utilization of the government information such as visions and statistics. Since the government information is an open and equal opportunity to all, so it is essential for SMEs to interpretation for their own future.

TAIWAN[18]

Location and resources are Taiwan's foremost assets for business development in Asia- the island's central location and well-developed infrastructure offer a strategic transit point for multinational companies seeking to enter the Chinese market.

[18] Source from Invest in Taiwan, Department of Investment Service, the Ministry of Economic Affairs (MOEA).

Taiwan's linguistic and cultural ties to the mainland of China can also help multinationals deal with issues related to investment, production, localization, and market segmentation. Furthermore, these ties make Taiwan an ideal test-bed for entering the Greater China market, as well as other markets in the region. Companies on the island have access to Taiwanese capital and a well-educated workforce. Taiwan has a high proportion of skilled workers and R&D workforce-National expenditure on R&D as a percentage of GDP rose from 1.66% in 1990 to 2.30% in 2002. Taiwan also has a human resource talent as reflected in its high number of patents.

Taiwan's industrial development is moving from traditional manufacturing goods towards more value-added production, innovation and design, changes which reflect Taiwan industries' readiness to adapt with the global business environment. Taiwan businesses have moved away from their past exporting strategy of concentrating on light and small products, focusing more on precision, higher added-value, vertical integration in supply chain production, and emphasizing products with high added-value, branding and marketing. Recent studies from the Ministry of Economic Affairs indicate that Taiwan's small and medium-size enterprises (SMEs) have developed a strong production and sales network with multinational companies as first-tier suppliers, and have the potential to develop further on this business model. This network, along with the island's R&D and innovation talents, provide a solid foundation for strategic alliances.

GOVERNMENT INCENTIVES IN TAIWAN

The Taiwan government supports investment in R&D through the Action Plan for Encouraging Foreign Companies to establish R&D using the following incentives:

- If an existing or newly established company invests in a high-tech industry or technical services industry, it will be granted a five-year exemption from business income tax.
- A company that invests in R&D or the personnel training in automation equipment, the Internet, communications or telecommunications products, electronics, television equipment, digital content production or other hardware, software or technology related fields will be allowed to list this investment as a deduction on the business income tax.
- Land in industrial districts can be rented at specially reduced rates. Rent is free for the first and second year; a 40% reduction is granted for the third and fourth year, and a 20% reduction for the fifth and sixth year.
- The restrictions governing the stock market and Over-the-Counter (OTC) listing of holding companies have been relaxed to make it easier for multinational companies to obtain funding.
- Relaxed restrictions on professionals in hi-tech and related fields coming to work in Taiwan.
- A single-window service aims to provide companies with convenient access to information and services.

CONCLUSIONS

This section is structured to give a description of the main weaknesses in Northern Ireland with corresponding recommendations, plus examples of good practice that have been used within other regions to support policy formulation[19].

Weakness 1: The small size of the Northern Ireland economy constrains the adequate supply of key R&D skills and resources. The peripherality of Northern Ireland within the UK places greater demands on the local skills base to respond to changes in skills or resources required to support R&D. R&D intensive regions within the UK have seen large fluctuations in employment over the past two years. For example, staffing surveys for the Cambridge Sciences Park show the catchment area servicing these fluctuations to extend from Birmingham to London. The much smaller equivalent catchment area servicing Northern Ireland means that it is at greater risk of temporary shortages in these resources given short-term demand.

Recommendation: Sharpen the focus on some of the priority clusters. DETI should consider carefully the niche areas in which it already enjoys a competitive advantage over other European or international regions, and decide how best existing resources can best be used to support these niche areas, rather than seek further diversification into new markets that may be identified from comparison with other regions.

Good practice: Embedding Nokia into the regional economy and using it as a focal point to develop a world class ICT clusters in North Finland. And world class ICT cluster, strong relationship between universities, research institutions and industry in Japan.

Weakness 2: There is a lack of awareness of the complete range of innovation support mechanisms available to business.

Recommendation: Rationalize the methods for telling business about support schemes, and improve the promotion of these schemes. For example, offering business vertical support through a supply chain is one alternative to support offered on a sectoral or functional basis. The former may also promote better cross-sector linkage and therefore serve to strengthen development of a knowledge-based economy within the region.

Good practice: Collaboration between supporting organizations in Sweden.

Weakness 3: Support available to business appears too light to facilitate adequate scale-up R&D activity. Although there is now plenty of proof-of-concept support available to university-based businesses and entrepreneurs, there does not appear to be appropriate funding that is readily accessible to wider business.

[19] Identified weaknesses based on DETI A comparison with the UK and other International Regions, R&D Business Expenditure in Northern Ireland, 2004.

For example, comments indicated that the funding limits under Compete offered by InvestNI[20] (50% of costs of £15,000 for Phase1, 40% of costs to £250,000 for Phase 2) were considered 'too light' for some commercialization activities, especially given the reciprocal scheme stewardship requirements that need to be met in order for qualification for Compete funding.

Recommendation: Expand the criteria used to assess eligibility of applications from business and ensure a better match of conditions of use to the size of support given.

Good practice: Wide variety of innovation funding sources in Sweden, for example grants, soft loans, 'intelligent' loan and venture capital.

Weakness 4: There are inadequate incentives for the results of University R&D to be applied to meeting user needs. The majority of funding of HE/FE institutions appears to be technology-driven. For example, whilst the academic institutions have led many areas of long-term research within the region, a number of comments suggest that they are less able to respond to short-term near-market research needs.

Recommendation: Reward university-business initiatives that increase the level of applied R&D activity.

Good practice: Creation of Australian Institute for Commercialization in Queensland. Tie-up University Research Institutions and Industry in Japan.

Weakness 5: Graduate ambitions do not appear aligned with an entrepreneurial career. Students from NI historically appear unwilling to pursue entrepreneurial careers in business.

Recommendation: Introduce teaching of entrepreneurship in the school curriculum to engender this from an early age.

Good practice: Teaching of entrepreneurship in Sweden. While teaching entrepreneurship at school level maybe is not widely practiced, teaching of entrepreneurship within universities and higher education institutions is increasingly common and recognized as important.

Weakness 6: Poor linkages have existed between companies within sectors and between sectors. The linkage of business within the region appears to be historically poor. A consequence of this is the poor embedding of many large companies that have been attract to the region. Historical reasons seem responsible for their presence within the region rather than strong business or community links[21].

Recommendation: Encourage cross-sector business development and promote this work to regional business.

Good practice: Academic-business networking fora in Finland and the strong relationship between Japanese research institution and industry.

[20] Source from InvestNI website.
[21] Source from DETI Research and Development Business Expenditure in Northern Ireland, 2004.

International comparisons show that neither peripherality, small size, industrial restructuring nor a history of low R&D investment need be an insuperable barrier to effective action to build a knowledge-based sector of the economy. The other regions have all developed innovative policies to overcome these barriers to a greater or lesser degree, and therefore there is much that Northern Ireland can exploit to its advantage. The table below summarizes best practice in relation to a number of structural weaknesses, in addition to those mentioned above, some of which may be helpful to Northern Ireland.