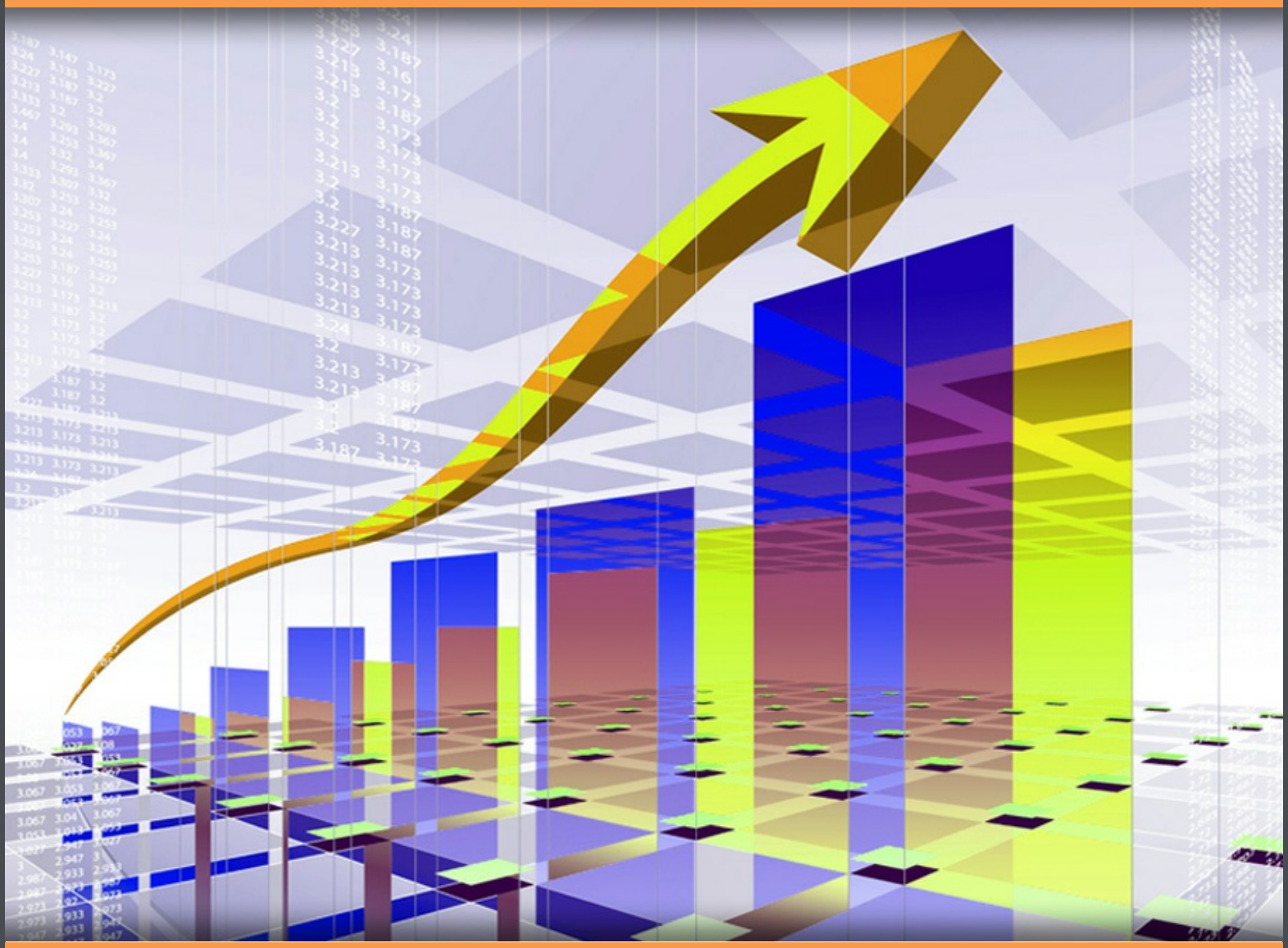
Innovation and Small Business - Volume 2

Brychan Thomas; Christopher Miller; Lyndon Murphy



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Innovation and Small Business

Volume 2

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Contents

Foreword

Small businesses because of their size lack resources and crucially the time and expertise available to larger businesses. However, because of their small size advantages relate to flexibility and responsiveness which can allow them to have closer contact to customers, be flexible in operations and respond quickly to change. Where smaller businesses can excel is in their constant and open communication and networking ability. Indeed, the creation of innovation and new know-how are examples of 'positive spillover' from existing types of relationships formed through networks.

For small businesses that have high technological competences and absorptive capacities, networking offers stronger opportunities for benefiting from knowledge transfers and spillovers from larger or from more advanced firms. Research interest has shifted from adoption issues towards more advanced adoption and use of technological innovations in small business processes and growth. In this sense there is a distinction between small *evolutionary* changes, where the adoption of more basic technological innovation are used to improve existing business practices, and *revolutionary* changes to the small firm's core business model through more advance technology applications.

Critical to whether small business technology adoption is evolutionary or revolutionary will be down to how they manage inward technology transfer. This will relate to their absorptive capacity, or their ability to learn, implement new knowledge, disseminate knowledge internally and make use of new resources, often in partnership with the sources of that new knowledge. Leading-edge entrepreneurial small businesses have effective organisational routines and systems (often through conducting their own R&D), and are well placed to develop the absorptive capacity to adapt and exploit innovative ideas that 'spill over' from their network and technological innovations.

This text of readings, in my opinion, is the first to comprehensively and in various industry contexts integrate and bring clarity to extant thinking on the effective use of small business networking relating to the optimal adoption and use of technological innovations. Chapters provide an intensive grounding in the key concepts and their relationships while also providing guidance for small business owner/managers, researchers and policy makers. I commend this text to students, researchers and scholars of small business and to small businesses who strive to thrive in the global knowledge economy.

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Geoff Simmons is a marketing academic with a keen interest in small businesses and their adoption of new technologies. His research interest in this context lies in marketing strategy and he has published his thinking in leading international academic Journals, including: European Journal of Marketing; International Small Business Journal; Environment and Planning A; Journal of Strategic Marketing.

Preface

On the global stage small businesses are represented in many different communities. At a UK and EU level small businesses are defined as having 10–50 employees and offer considerable scope for innovation and productivity. Additionally, the European Union Research and Advisory Board (EURAB, 2004) has provided a helpful typology in terms of the amount of R&D that is undertaken. Four basic categories provide insight into the level of use and the extent of R&D that is conducted. A basic category of some seventy percent of small businesses undertake little or no R&D; about twenty percent are technology adopting adapting existing technologies as low innovative businesses; less than ten percent combine or develop existing technologies at an innovative level; and less than three percent are involved in high level research. The distinctive characteristics of, and pathways into, leading technology users as they attain a critical market edge therefore require identification.

Small businesses that are early adopters of more advanced technology applications tend to be more entrepreneurial in their growth strategies and core opinion formers in their networks (Cohen and Levinthal, 1990; Zahra and George, 2002; Gray, 2006). They are likely to conduct more research and R&D or adapt technological applications to their requirements than other small businesses. It is therefore hoped that this second volume will provide a greater understanding of these innovation dynamics for small businesses in industrial settings.

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Dr. Brychan Thomas, Dr. Christopher Miller and Lyndon Murphy
Cardiff and Newport
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1 Introduction

Brychan Thomas, Christopher Miller and Lyndon Murphy

> *"Never before in history has innovation offered promise of so much to so many in so short a time."*
>
> BILL GATES (1955–)

This chapter at a glance

- Innovation and Small Business in Industrial Settings
- Innovation Networks and Small Business
- Organisation of the Book

Innovation and Small Business in Industrial Settings

Due to the increasing influence of technology on company strategy and the important role of technological progress in the stimulation of industrial development, and the complexity and diversity of modern technological practices (Gold, 1987), many small businesses are experiencing difficulty in gaining access to certain technologies. Indeed, it is increasingly suggested that access to technologies by small businesses can best be achieved by encouraging the formation of networks of innovators. Such collaborative arrangements are essential to improving the competitive position of small companies, predominantly through the accomplishment of mutually beneficial goals such as the acquisition of state-of-the-art technology (Forrest and Martin, 1992). Such innovation support networks serve to externalise the innovation function through the transfer of technology between firms (Lawton-Smith et al., 1991). During the last twenty five years industrial innovation has become significantly more of a networking process, with collaborations increasing considerably (Aldrich and Sasaki, 1995). Indeed there is mounting evidence of network relationships between small businesses, especially the transfer of technology (Lipparini and Sobrero, 1994). It is likely that small businesses will become more dependent on external sources during the innovation process.

Innovation literature has long demonstrated the importance of external sources in the development of successful innovation (Carter and Williams, 1957). These studies tended to focus on the identification of the sources and types of knowledge and technology often neglecting the nature and origins of the relationship linking the recipient (the innovator) to the source of technological innovation. There has been little investigation of the more informal sources of technology, especially the process of transfer supported by innovation networks.

Innovation Networks and Small Business

Through forming innovation support networks small businesses with complementary skills can maximise their innovation output from limited research and development (R&D) resources. Nevertheless, 'networking' is not a 'cure' to the human, financial and technical resource difficulties of small businesses. Deficient innovative capacity is unlikely to be overcome by replacing R&D activity by external 'know-how' and technology. Internal R&D not only produces new information but also evolves external know-how and technology (Cohen and Levinthal, 1989). Freeman (1991) has argued that 'the successful exploitation of imported technology is strongly related to the capacity to adapt and improve this technology through indigenous R&D'. It, therefore, appears that the innovative capacity of small businesses is best served by developing a balance between the technical and network support aspects of an enterprise, rather than relying on one or the other.

According to Revesz and Boldeman (2006) the economic reason for governments to support R&D is based upon the externalities (spillovers) caused by R&D which has received much interest in innovation literature. Further to this two roles for R&D suggested by Griffith et al (2004) are to stimulate innovation and to create an understanding of discoveries by others which to the originating firm are confidential. A major policy question concerning R&D will be the extent to which indigenous technology progress is created by local R&D or by developments globally (Revesz and Boldeman, 2006). It must be borne in mind that economic growth can be created through assimilated disembodied knowledge (education, learning, R&D, knowledge systems and economic reform) contrary to the embodiment of technology innovations in imports (DCITA, 2005). The economic impact of R&D on an economy is therefore of importance. It has been found that R&D does not provide a true picture of innovation in small businesses since smaller enterprises will not have a specialist R&D department (Crespi et al, 2003). Further to this it appears that most innovations originate in certain sectors (Robson et al, 1988) as likewise most R&D (Scherer, 1982).

Organisation of the Book

This volume considers innovation and small business in industrial settings and includes studies of the agri-food, health, energy, construction and museum sectors.

Chapter 2: Agri Food – Innovative and Sustainable Solutions

In terms of agri food innovative and sustainable solutions the chapter focuses on knowledge transfer, community food projects, farmers' markets, benchmarking and best practice. It is recognised that there is a need to develop what can be described as a "new" business environment for the Agri-food industry. The chapter considers the issues and reports on possible solutions that are both innovative and sustainable towards improving Agri-food business activity. It concludes by outlining a business environment model for the sustainable development of Agri-food SMEs relevant to farming communities.

Chapter 3: Health – Assessing Research and Development in Health sector small companies

In order to assess research and development in health sector small companies the health business sector, health sector firms, a case study approach and health sector company case studies are presented. The technological development of health sector small companies is influenced by various sources of know-how including R&D, industry contacts, learning, and ICT. R&D is therefore a major source for technological progress in these businesses. A principal justification for R&D activities will rest upon the positive spillovers which are the positive externalities from R&D (Revesz and Boldeman, 2006).

Chapter 4: Energy – Sustainable Energy through Research and Development

The overall energy picture is given followed by consideration of energy sector firms, a case study approach, company case studies, a case study summary discussion and the challenges in commercialising sustainable energy research. A considerable proportion of the energy industrial base is focused on large power generation and usage. Due to this it is affected by changes to the economics of energy and the technology base. As a consequence there is an incentive for companies to lead the development of energy processes. One of the advantages for small companies is skills availability in the industrial technological R&D and HEI sector. Long term energy strategic objectives and technology opportunities will involve industrial research.

Chapter 5: Construction – Innovation, Technology and Small Construction Enterprises

A discussion of Small Construction Enterprises and technological development, innovation, technology and key success factors is provided. This chapter considers the reasons for innovation and the barriers to innovation. The factors that may then enable effective innovation to take place such as technology transfer networks, "good practice" and training are explored, with conclusions describing a way forward.

Chapter 6: Museums and Small Memory Institutions – Multimedia Knowledge Management Systems

The chapter considers the diffusion of multimedia knowledge management (KM) systems into global museum markets at the level of the small museum and small memory institution (SMI). In particular, knowledge management, knowledge management trends, multimedia knowledge management systems, global marketability and museum networks are investigated. Diffusion in the form of multimedia technology, knowledge transmission and technological expertise is explored. The diffusion of multimedia KM systems is considered including external sources, channels of technology transfer, and mechanisms involved in the transfer of the technology into the innovative SMI. This is related to museum networks in terms of the adoption of multimedia KM systems by SMIs.

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2 Agri Food – Innovative and Sustainable Solutions

Said Al-Hasan, Robbie Williams and Brychan Thomas

> *"Agriculture, manufactures, commerce and navigation, the four pillars of our prosperity, are the most thriving when left most free to individual enterprise"*
>
> THOMAS JEFFERSON (1762–1826)

This chapter at a glance

- Introduction
- Knowledge Transfer
- Community Food Projects
- Farmers' Markets
- Benchmarking and Best Practice
- Conclusions

Introduction

In order to enhance the future prospects of Agri-food small and medium-sized enterprises (SMEs) and farming communities there is a need to create an environment for their sustainable development. Indeed, environmental changes have forced a major re-evaluation of Agri-food assistance measures devised by policy makers, local and regional government, to be implemented through their agencies. It is recognised that the "new" business environment for the Agri-food industry requires solutions that are both innovative and sustainable towards improving Agri-food business activity. This chapter reports on possible innovative and sustainable solutions to current local Agri-food problems, which are economically, environmentally and socially complementary. The chapter outlines a business environment model for the sustainable development of Agri-food SMEs relating the case of farming communities in Wales involving knowledge transfer, community food projects, farmers' markets, and benchmarking and best practice. It is the proposition of this chapter that Agri-food SMEs and farming communities can attain sustainable development through the creation of a "new" business environment. In order to achieve this a business environment model is outlined involving a loop of knowledge transfer, community food projects, farmers' markets, and benchmarking and best practice.

Knowledge Transfer

Knowledge transfer activities in local Agri-food systems are taking place against the background of the global market system and the strategic choice is whether to be incorporated into this system or to adapt to global dynamic change though alternative, 'non-commoditised' markets (Commins & McDonagh, 1998; van der Ploeg, 1994). It is commonly through the latter strategic path that value-adding Agri-food SMEs are attempting to grow.

Previous studies, when considering the issue of knowledge transfer in the Agri-food industry, have focused, in particular, on the dynamics of Research and Development (R&D) (Wilkinson, 1998). It appears that low levels of internal R&D among Agri-food firms are consistent with strategies devoted primarily to superficial product innovation. As a consequence this points to a systematic long-term effort towards greater inter sectoral knowledge flows.

Knowledge and its diffusion is considered a key development factor within rural Agri-food districts. A continual process of adaptation and improvement of knowledge is one method of achieving a competitive advantage. This was highlighted by Bradley, McErlean and Kirke (1995) in their study of technology and knowledge transfer in the Northern Ireland food processing sector with regard to the recognised importance of technology transfer as a major source of improvement in the competitive position of firms and industries. Within the Agri-food industry technology has been shown to be transferred from geographically close industries and this has been highlighted from examples of fruit refrigeration technologies being adopted by neighbouring ham producers (Fanfani, 1994). This demonstrates the importance of locality in promoting entrepreneurship and there is significant evidence that regional prosperity is proportional to the degree of SME existence (Sweeney, 1985). Cooke and Morgan (1998) describe six essential elements of a national system of innovation – the role and type of Research and Development (R&D), education and training, the financial system, user-producer relationships, intermediate institutions (trade associations, development agencies such as LEADER II Groups, etc.) and social capital (networks, norms and trust). Koku (1998) has drawn attention to the strategic nature of information management for innovations in national food systems.

The current over-arching agri-food strategy in Wales is called the Agri-Food Partnership. Launched in March 1999, this initiative is an attempt by both the development institutions of Wales, the National Assembly for Wales, LEADER Groups, universities, FE colleges, farming unions and private consultants) and industry leaders to develop an integrated and coherent strategy to guide and assist the development of the Welsh Agri-food industry. The guiding principles of the strategy state that actions within it must be 'focused firmly on addressing the relevant trends in market demand; be practical and realistic; and carry commitment from both the industry and relevant organisations in Wales' (AFP, 1999, 4).

The Agri-Food Partnership has taken a sectoral approach to the strategic development process. The sectors chosen are Lamb and Beef, Dairy and Organic. These have been identified on a basis of current production or, in the case of the Organic sector, on perceived future trends and potential. The initial output of the Partnership has been the publication of 'action plans' for each of these sectors (Welsh Lamb and Beef, Dairy, and Organic Industry Working Groups, 1999). Industry Task Forces for each of the three sectors co-ordinate the implementation of these action plans. They are represented by the chairpersons of the Lamb and Beef, Dairy and Organic Task Forces in the Agri-Food Partnership which is responsible for reviewing the action plans with the National Assembly.

Coupled to the forms of knowledge transfer described the three main types of external sources involved in the diffusion of knowledge into Agri-food SMEs are:

- public and non-profit organisations (regional/national development organisations (R/NDOs)),
- regional technology advice centres,
- and Regional and Technology Organisations (RTOs) (contract research firms, science parks and technology centres such as the Food Technology Centre at Coleg Menai).

Amongst the three types public bodies undertake policy programmes, regional technology advice centres concentrate on providing focused assistance and technology centres provide knowledge and know-how. For Agri-food SMEs involved in local networks (Volpentesta and Ammirato, 2008) key mechanisms include information transfer (newsletters and databases), technology transfer (R&D audits), skills transfer (training) and specialist support (financial guidance). Value for money of the mechanisms will be a key policy measure. Policy makers will need to be careful that changes in priorities will not make an Agri-food SME withdraw from knowledge transfer activities and that policy reacts to difficult situations by providing Agri-food SMEs with incentives.

Support through local food networks includes specific support provided to individual Agri-food SMEs (assistance during the establishment of local network relationships) (Volpentesta and Ammirato, 2008) and knowledge transfer support to Agri-food SMEs in general have been through drivers such as the Wales Regional Technology Plan (RTP) (WDA, 1998) (to foster technological knowledge and establish network links with external sources such as FE Colleges and Universities for the dissemination of know-how into Agri-food SMEs).

Community Food Projects

Community food projects involve food production and consumption in the same locality – local farmers selling to local shops involving publicity and promotion (Morley, et al, 2000). They are increasingly being recognised as an important instrument for the sustainable development of the Agri-food industry in Wales. Community food promotion can involve schemes which include the use of labelling and certification marks for local food products (Skaggs, Falk, Almonte & Cárdenas, 1996). These projects can help to preserve and protect local farming systems. An important mechanism for achieving this is the projection via labelling of locally identifiable foods to local consumer markets (Marsden, 1998). Potential benefits of these labels are:

- the establishment of competitive advantage to local Agri-food producers and processors
- the enhancement of premium products
- the assurance that processing activity takes place within the local community thereby benefiting the local economy (Ritson & Kuznesof, 1996).

Examples of the marketing of regional foods in the United Kingdom are 'A Taste of the South East', 'Middle England Fine Foods', 'Taste of the West', 'Heart of England Fine Foods', 'North West Fine Foods', and 'Tastes of Anglia' (Food from Britain, 2009). In Wales there are a number of localities marketing their food products in a collective way (Lamprinopoulou et al, 2006), particularly with farmers' markets, including Cardiff, Carmarthenshire and Pembrokeshire (Farmers Markets in Wales, 2010), and nearby in England Bath, Bristol and the Forest of Dean (The Best of Forest of Dean Food and Drink Directory, 2010). The importance of local origin of a food product is thought to be significant, but likely to vary depending on the food types and locality. It has been found that product origin is extrinsic to the product itself and can, therefore, be beneficial when the product is unknown to the consumer (Skaggs, Falk, Almonte & Cárdenas, 1996). The importance of food origin can be significant to the growth in value of marketing localities as a whole. This will serve to increase cost efficiency and foster synergistic links between products under the same 'banner'. Association of various products and characteristics with regions, however, can have a negative effect if a certain element becomes a negative association (examples of this are Chernobyl fallout affecting Welsh hill sheep farming and the BSE crisis having a deleterious effect on the Welsh beef industry). It is only by educating the public that such fears can be allayed.

The marketing of local foods on the basis of origin also allows the possibility of benefits from ethnocentrism amongst consumers. The desire for Welsh people to eat local products can be valuable to local food producers especially Agri-food SMEs. This is apparent through the existence of 'Welsh' food products in multiple retailer outlets across Wales. It is also possible to target people of Welsh origin (or with strong sympathies towards the Welsh and Wales) in other areas of the United Kingdom or overseas (Skaggs, Falk, Almonte & Cárdenas, 1996).

There appears to be an identifiable linkage between local food products and the tradition and heritage of the local area. This was a finding from respondents to a study which investigated UK consumer perceptions of regional foods (Kuznesof, Tregear & Moxey, 1997). One of the conclusions was that, in the perception of consumers, both the local customs and the physical locality contribute favourably to their definition of a regional food (Tregear, 1998). These consumers also linked regional foods to notions of 'authenticity'. A further dimension of locality that is of importance to food businesses is the nature of the consumer base. By identifying local demand feedback mechanisms between consumers and supply chain (Matopoulos et al, 2007) participants can be established (patterns of innovation and development in the food chain have been studied by Cannon (1992)). This can provide a reliable consumer base and build credibility with external markets (van der Meulen & Ventura, 1995) (Fanfani, 1994).

Consequently, the characteristics of local demand are perhaps more important than the size of the demand. Supply chains (Matopoulos et al, 2007) with a significant local demand are more able to recognise purchasing needs, particularly emergent demand which tend to take longer to transmit from more remote consumers. Additionally, companies with sophisticated and demanding local consumers are likely to benefit through the requirement to comply to their 'advanced' needs, keeping them one step ahead of external consumers and competition (Porter, 1990).

The authors have been involved with community food projects in Wales through their work with local and strategic research initiatives – 'Local Food for Local People' (WEI, 1999a), and the project 'FE Colleges, SMEs and Technology Transfer Networks in the Welsh Food Industry' (WEI, 1999b). The 'Local Food for Local People' study by the Welsh Enterprise Institute aimed to increase consumption of locally grown food in the Bridgend County Borough Council area. The outline aims were to:

- encourage groups and individuals (both commercial and not for profit) to grow and produce their own food
- develop a supply infrastructure to enable produce to be available at recognised outlets within the community and to communicate this feature to the stakeholder groups
- raise awareness of the health, social, economic and environmental issues associated with food production and consumption
- encourage eco-friendly practices in the Bridgend County Borough Council area.

The objectives of the initiative that the parties involved with this project and the co-ordinators (Bridgend County Borough Council) and Community Service Volunteers (CSV) Wales were investigating included:

- supply side logistics and market attractiveness
- the likely uptake of a 'directory' style publication to publicise local foods
- the attractiveness of a 'farmers market' style outlet
- any existing 'best-practice' frameworks – both nationally and internationally.

The 'FE Colleges, SMEs and Technology Transfer Networks in the Welsh Food Industry' initiative, also undertaken by the Welsh Enterprise Institute, involved a study of the role of FE colleges in the transfer of technology within the local Agri-food SME sector in the Welsh Food industry. It considered the importance of external sources of inputs, in the development of successful technological innovation, within small food firms in Wales. The focus of the project was to:

- determine the external sources of inputs into the development process including the importance of the role played by FE colleges
- the nature and importance of the inputs
- the nature of the relationships through which these innovation inputs transfer into the innovative SME in the local Agri-food industry, and
- mechanisms employed in their transfer.

The role of external actors, such as community users, suppliers and FE colleges was considered, as well as the impact of Agri-food firms and organisations linked together in patterns of co-operation and affiliation. A network of participating FE colleges was set up, by the Welsh Enterprise Institute, and each college had its own network of Agri-food SMEs.

These initiatives were particularly timely in relation to debates regarding the sustainable development of local Agri-food SMEs and the improvement of the Welsh farming environment, which was high on government agenda, due to the need to deal with policy issues such as food standards, for example.

Farmers' Markets

Farmers' Markets (FMs) have been defined as "food markets where farmers and producers bring their produce for sale direct to the public" (Bullock, 2000). Markets usually have rules including those that food cannot be brought in and sold, and that food should be from "local" producers. Individual markets determine the definition of local produce. Accreditation for markets in the UK is determined by the National Association of Farmers' Markets (NAFM), which exists to ensure that standards are maintained. Since 1997 more than 240 FMs have been established in the UK and turnover at these markets has increased (NFU, 2000). Annual sales from FMs in the USA was over $1billion in 2000 (Bullock, 2000). In fact, FMs have been flourishing for more than 25 years in the USA. According to Festing (1998) 90% of Illinois' 147 FMs were sponsored by a chamber of commerce or a merchants' association with the US Department of Agriculture reporting that 85% of FMs have been economically self-sustaining. It has also been observed that "though they are not an economic development panacea, farmers' markets should be considered an important component of a comprehensive local economic development strategy" (Hilchey, et al, 1995).

The commercial exchange which takes place at a FM is not new, but in the 20th Century the linkages between producers and consumers was lost with the methods of food production, distribution and retailing used. As a consequence the re-establishment of direct linkages between producers and consumers has been re-born with the evolution of FMs at the start of the 21st Century. The direct contact between producers and consumers is pivotal to the success of FMs with a basis of integrity and transparency for food provision. As a consequence the South East Wales Association of Farmers' Markets (SEWAFM) was created with an understanding that if FMs are to have a significant and sustained future they need to be viewed within the wider context of the development of a sustainable local food economy. The aim of SEWAFM was that the member markets become examples of good practice since the Association promoted and facilitated the highest standards within the region and supported the endeavours of individual members to these ends.

The functions of SEWAFM were:

1. co-ordination of FMs in the region
2. to create and maintain a database of producers
3. accreditation
4. training
5. promotion
6. supply

7. development of complementary direct marketing structures
8. establish and maintain a knowledge bank
9. develop links with other regions
10. become a focus for dialogue and co-operation
11. provide a conduit for funding.

The functions were adhered to through membership, following application, by the markets involved in the area and markets agreed to abide by the criteria based on those defined by the National Association of Farmers' Markets (NAFM), as listed below:

1. Local produce – only produce from the defined area is eligible.
2. Own produce – all produce to be grown, reared, caught, brewed, pickled, baked, smoked or processed by the stall holder.
3. Principal producer – the stall must be attended by the producer or a representative directly involved in the production process.
4. Policy and information – information should be available to customers at each market about the rules of the market and the production methods of the producers. The market should also publicise the availability of this information.
5. Other rules – markets may establish other criteria in addition to the above provided they do not conflict with them.

Members agreed to abide by and support the decisions of the SEWAFM committee, which ran the Association, and it was agreed that markets would only use producers from an accredited list. The Association was a constituted voluntary body of representatives from FMs, unitary authorities (principally economic development and Agenda 21), farmers' unions and the then Welsh Development Agency (WDA), drawn from the South East region of Wales. A Web site was developed following the identification of a need by SEWAFM to link together current and prospective farmers, FMs and their customers in the South East Wales region. The objective of the site was to provide information on farmers' products, new produce and developments, events and issues of importance to farmers and their markets. In order to do this the Web site provided a page for each farmer to sell his/her produce and a facility for customers to search for the products they wanted at the right price.

Benchmarking and Best Practice

Common areas for "bench-marking" and "best-practice" are knowledge transfer and skills (determining an Agri-food SME's needs), technological expertise and know-how, service provision, management and organisation (CEC, 1998). Good practice for the successful operation of a network (such as farmers' markets) is the realisation by Agri-food SMEs that it is not only an alliance of enterprises but also a partnership of entrepreneurs. (Entrepreneurs will act as gatekeepers and will have an important role to play in the operation of networks) (Thomas, 1999). "Best-practice" procedures disseminated through local networks (Volpentesta and Ammirato, 2008) include minimum quality standards for management and product quality and the sourcing of external funds. Working against this is the SME's dislike of revealing confidential activities and specific performance data. Procedures usually become less formal over time due to ideal size attainment and growth realisation.

Indicators of the successful local communication (Donnelly, 2009) tools (newsletters, Web sites, etc.) and good relationship management between the Agri-food SMEs will form the basis of good practice for the operation of a local network (Volpentesta and Ammirato, 2008). This is not easy to attain since the process of knowledge transfer can be long and without success, the results of a local network are difficult to define and there may be discrepancies and disagreements between the Agri-food SMEs. "Low" activity may arise due to conflicts in a local network. When these are efficiently managed and resolved they provide opportunities for the Agri-food SMEs to broaden their experience and widen their understanding of other Agri-food SMEs' views. When they are not conflict may lead to "low" activity. Conflict management and identification form part of successful "best-practice". Typical examples of "low" activity will be misunderstanding between Agri-food SMEs, different objectives and motives and under-performance of an Agri-food SME.

Conclusions

There is considerable scope for the sustainable development of local Agri-food SMEs, to improve quality and lower costs, by adopting "best practice". Knowledge transfer, training, information and advisory services if brought together in a coherent framework will lead to the improvement of the farming environment. At the local community level there are clear benefits for the use of branding by Agri-food SMEs to publicise local foods not only to local people but also to people of local origin or with strong sympathies towards local food products. This can be achieved through vehicles like community projects, information and communications technology (ICT) (Cetin et al, 2004) and the Internet (Simmons et al, 2007).

The focus on examining "best practice", where there is benefit to Agri-food SMEs, can result in effective "bench marking" of significance to the farming environment. Bench marking can be undertaken for Agri-food SMEs' innovative practice against the best in the "class" and by doing this they can improve their competitive positions through awareness and the greater use of bench marking techniques.

It is the contention of this chapter that solutions such as knowledge transfer, community food projects, farmers' markets, and best practice techniques can be brought together to form a business environment model, as outlined in Figure 2.1, to enable the sustainable development of Agri-food SMEs relevant to farming communities.

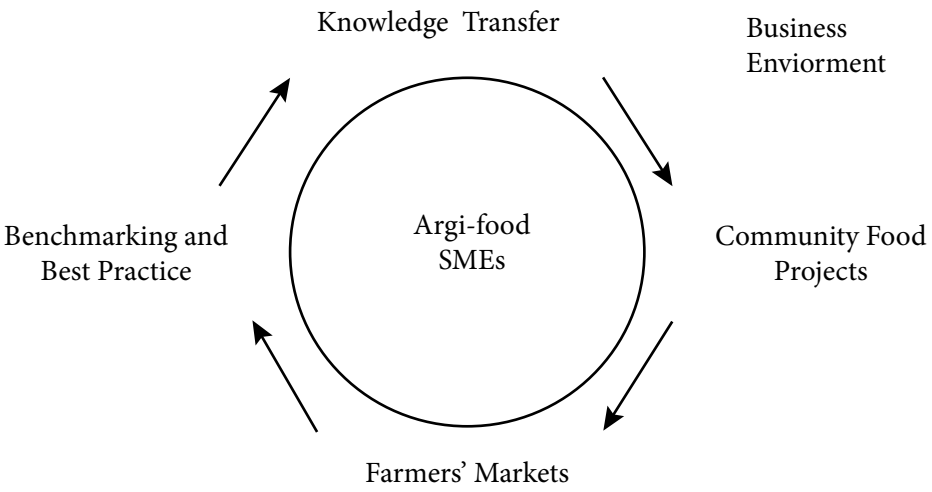

Figure 2.1 A cyclical business environment model for the sustainable development of Agri-food SMEs relevant to farming communities

In order to test this model there is a need for evidence that knowledge transfer takes place by "talking to consumers". Further work will need to consider the consumer knowledge aspect of the model. This is important since the knowledge aspect provides a link to other studies that are being carried out to consider environmental business support and information sources for environmental purchasers. This will enable an explanation of the current knowledge base and show why it needs to be revised.

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3 Health – Assessing Research and Development in Health sector small companies

Brychan Thomas, Gary Packham and Christopher Miller

"It is health that is real wealth and not pieces of gold and silver"
MAHATMA GANDHI (1869–1948)

This chapter at a glance

- Introduction
- Health business sector
- Health sector firms
- Case study approach
- Health sector company case studies
- Summary/discussion
- Conclusions

Introduction

This chapter considers research and development (R&D) in Health sector companies in terms of their activities and developments. Initially this is investigated from a general assessment of the Health business sector involving research collaborations and the commercialisation of ideas through partnerships between industry, Higher Education (HE) and the National Health Service (NHS). Definitional aspects of the Health business sector are then considered in terms of the classification of health R&D performers followed by definitions of health R&D. A case study approach is undertaken to explore the R&D activities of three health sector companies. Following a summary/discussion of the findings in relation to government policies conclusions are drawn with regard to the technological progress of health sector small companies.

Health business sector

Complex challenges will need to be met if effective mechanisms are to be developed between the health business sector, innovators, the National Health Service (NHS) and individuals. In relation to this four key themes were identified in a review of bioscience (Ernst Young, 2003) and these were building the science base, innovation and commercialisation, critical mass and unified leadership. This is appropriate to the research spectrum involving basic research through to translational research. Two hundred and ninety companies active in bioscience were identified in the review and these included drug discovery technologies and systems, non-invasive surgery, diagnostics (in vivo and in vitro), medical devices, clinical trials and pharmaceuticals. It recognised that there is a need for research collaborations which are multidisciplinary when appropriate and for there to be active partnerships between industry, academia and the NHS. This is highlighted by clinical research where to meet the needs of industry there is a need to move towards a single system that delivers quality and rapid access at reasonable costs (McKinsey, 2005). In order to build collaborations in bioscience the industry networks have been established. There are also the NHS networks provided by health professional advisory committees. It is believed that these could work together to determine potential clinical collaborations within the NHS to provide access points for industry. For the commercialisation of ideas partnerships between industry, HE and the NHS can generate income of benefit to research through reinvestment. There are also links with the devices industries through the pharmaceutical industry and the Association of the British Pharmaceutical Industry (ABPI). It is therefore possible to develop existing strengths in the health business sector through collaboration across businesses and organisations to share facilities, expertise and best practice.

Health sector firms

In order to help define the health sector SIC codes can be used to classify health sector firms (Table 3.1).

Listing number	Health sector	SIC code
1.	Biotechnology firms	7310
2.	Pharmaceutical firms	2441, 2442
3.	Medical equipment firms	3310
4.	Health product firms	2441, 2442
5. *	Alternative health product firms	2570, 6410
6.*	Other health firms	3443, 4130

Table 3.1: Health sector firms SIC codes
5.* & 6.* alternative health and other health products

To provide a comprehensive coverage of health sector companies the following alternative cures, products and health foods are included.

5. Homeopathic preparations (manufacture)
6. Hearing aid (electronic) manufacture
7. Baby foods (manufacture)
8. Baby foods (milk based) manufacture

Health sector firms can be categorised according to a classification for health R&D performers as follows:

1. Biotechnology firms
2. Pharmaceutical firms
3. Medical equipment firms (including instrumentation and diagnostic equipment)
4. Health product firms
5. Alternative health product firms
6. Other health firms

For the definition of "R&D" in the health context the definitions of R&D and health research R&D used by the OECD have been adopted for this study (OECD, 1994):

"Research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this knowledge to devise new applications."

The definition of "R&D" in the health context is as follows:

"Health research and development is a process for generating systematic knowledge and for testing hypotheses, within the domain of medical and natural sciences as well as social sciences including economics and behavioural science. The information resulting from this process can be used to improve the health of individuals or groups."

The main categories of the classification of health R&D (based on the Global Forum for Health Research) have been followed:

1. Non-oriented, fundamental research
2. Health conditions, disease or injuries (classified by disease)
3. Exposure, risk factors that impact on health (determinants)
4. Health systems research
5. Research capacity building

Therefore the "R&D" definition in the health context is generic and covers a wide range of health activities appropriate to the health sector.

Case study approach

In order to explore the internal and external R&D activities of companies in the health sector it was decided to use the case study approach – the results of which are reported in the case studies in this chapter. The case study approach involved extensive examination of the phenomenon of research and development in the organisations researched. Indeed, some of the most interesting research to emerge in the twentieth century has been derived from research undertaken within a small number of organisations (Bryman, 1989). Although case study research declined during the 1960s it has experienced an increase in popularity in recent years and now represents a sound methodological paradigm (Yin, 1994).

The case study approach is an example of a phenomenological methodology that has been used as a valid research methodology (Tellis, 1997). It is important to understand for case study research that the context of the research is of paramount importance. Data for the case studies has been obtained from information relating to the organisations investigated. These have been combined with secondary and internal data sources from the organisations for completeness. The case studies offer a methodology through observation, reconstruction and analysis that provides a thorough investigation to the research (Tellis, 1997). It is also argued by Aaker et al (1998) that case studies are often a logical method of analysis in a complex situation. However, case study research has often been criticised since it is claimed that it is designed incorrectly. In fact, this view arises from the opinion that the case study research structure has traditionally been loose and emerging in terms of data collection.

Three case studies have been undertaken in the health sector and these are reported below according to the company background, research and development and conclusions.

Health sector company case studies

Medrug Ltd

Company background

Medrug Ltd designs and predicts selective therapeutic agents in the G Protein-coupled Receptor (GPR) area with special reference to developing alleviating agents in the areas of asthma, cardiovascular disease, incontinence and Alzheimer's disease. The company is a computation based rational drug discovery firm. The objective is to discover better medicines for the treatment of common disease. This is through the fast optimisation of molecules which the company designs to act upon receptors involved with these diseases.

Research and Development

Medrug's focus for R&D is G-protein coupled receptors (GPCRs) with considerable therapeutic and economic potential. This is evidenced through more than 50 percent of drugs marketed (more than 25 percent of the leading one hundred best selling drugs) by targeting twenty GPCRs, treat a broad range of diseases. Consequently, the central element of pharmaceutical research is the development of highly selective and specific small molecule ligands that modulate GPCRs. Recently the pharmaceutical industry has given more attention to identification of new potential drug targets. This has been driven by developments in Genomics and Bioinformatics. It is believed that in the short term this will increase drug discovery costs and development. It is Medrug's approach to concentrate on lead identification and optimisation of targets in areas of unmet clinical need that have some existing level of validation. Here there may be an opportunity, through greater specificity and selectivity than those drugs in development, to produce new drugs. Medrug's objectives therefore are to discover drugs in terms of efficiency and efficacy that make a significant improvement on what is available in the market.

The scientific expertise of Medrug Ltd is in its small highly effective team of World class pharmacologists and chemists, computational analysis of protein 3-D structures using state of the art commercially licensed software and rigorous interpretation, through the Davies-Nederkoorn model of the structure and mechanisms of GPCRs, of drug-receptor interactions. These provide a platform to identify and test pharmacologically active modules that interact at receptors in targeted disease pathologies. This enables novel compounds to have accelerated adoption in the pharma pipeline by reducing lead optimisation time.

Conclusions

The strength of Medrug Ltd is in its use of extensive past research by scientists in the area of GPCR on drug receptor interactions. This has resulted in the development of a structural mechanism for GPCRs which will challenge, on the basis of mode of action, other models. A precise understanding of the mode of action for use in the design of stimulatory and partially stimulatory molecules has been acquired by Medrug's scientists. Therapeutic targets are diverse representing a large population of patients with high level of unmet need. Areas where drugs are under development are for Alzheimer's disease, acute heart attack and urinary incontinence. Business expertise is in the biotechnology and pharmaceutical industries through the members of the board of directors.

Medmicro Ltd

Company background

Medmicro Ltd offers sophisticated controlled release systems to the pharmaceutical industry. Medmicro is a particle engineering company taking to market a novel micro-reactor technology for the development and production of high quality particles for the pharmaceutical, food and cosmetic markets. Medmicro's unique bio encapsulation technology has applications in a range of therapeutic areas including cell therapies, small molecules and biopharmaceuticals. The company is addressing the limitations of drug delivery through the development of novel controlled release systems. Through integration of expertise in cell biology, polymers and micro fluidics Medmicro is developing novel micro encapsulation systems and production technologies suitable for a broad range of therapeutic applications. Core technology is being applied for the collaborative development of drug delivery systems for biotechnology and pharmaceutical partners in the areas of vaccines, adjunct therapies, cell therapies, combination products and controlled release of biopharmaceuticals and small molecules.

Since the drug discovery market is becoming increasingly competitive controlled release and delivery technologies with the aim to achieve sustained and localised delivery of therapeutics in the human body are of considerable importance to the pharmaceutical industry. In fact, controlled delivery has potential to reduce side effects, improve drug effectiveness and increase patient acceptance. Novel controlled release technologies will enable wide applications including clinical development of therapies, generics that can benefit from a new commercial life cycle, new drugs with delivery not developed and patent extension for proprietary drugs.

Research and Development

A breakthrough bio encapsulation technology for controlled delivery and sustained release of therapeutics using microcapsules has been developed in response to limited current drug delivery systems. These can be produced in commercial volumes using GMP compliant micro plants, maintain drug stability, achieve product uniformity and quality and are designed for optimal release rates.

The key advantage of Medmicro is the suitability of the technology developed for encapsulating therapeutic material and the capability to design, develop and produce polymer microcapsules. These can be produced in commercial volumes using GMP compliant micro plants, are finely loaded with active ingredients (small molecules, biopharmaceuticals and cells) and use a broad range of biocompatible polymers.

The management team includes the chief executive, business development director and technical manager; there is a board of directors involving the chairman, a non executive director, the business development director, chief executive and non executive director and a scientific advisory board composing three leading experts.

The services provided by the company involve applying the core technology for collaborative development of drug delivery systems for pharmaceutical and biotechnology partners. Through design, development and implementation the company offers its clients the opportunity to develop more efficient micro particle processes. In order to do this Medmicro uses a unique and wide range of engineering expertise, materials and chemistry through a range of services. These include the identification of regulatory and validation issues to be addressed, scale-up of microcapsule production volumes and rapid microcapsule development using proprietary micro fluidic technology.

With regards to collaborative research agreements from an initial proof of concept engagement Medmicro works with clients to develop micro particle technology to implement under licence. Concerning partnerships Medmicro is interested in partnering companies with the aim to co-develop controlled release therapies based upon bio encapsulation technology. Further to this, regarding "in licensing" Medmicro seeks opportunities to "in-licence" technologies to enable development of novel therapies.

Medmicro applications involve a smart drug delivery capability to enable a wide range of therapeutic applications including biopharmaceuticals (development of controlled release biopharmaceuticals that confer distinct advantages over existing formulations), small molecules (encapsulation technology enables new and controlled release versus existing small molecule therapies to be developed) and cell therapies (cell based therapies enable localised and sustained drug delivery under the control of the body's natural feedback mechanism and offer the potential for improved treatments for a range of chronic diseases).

Conclusions

Medmicro was formally launched with the launch of a unique technology for the fully scalable manufacture of micro- and nano particles. Two months later Medmicro won a technology investment by raising almost £500,000 with help from large name backers in order to bring their "cutting edge" technology developed to the market place. The company made further progress with their micro fluidic technologies entering their next evolutionary phase with foundations rooted in "lab on a chip" systems. By the end of the year Medmicro announced the signing of a collaborative research deal with a medical device company focused on the treatment of cardiovascular disease, cancer and benign tumours. Success followed with Medmicro being included in the final 50 Real Business most exciting and innovative companies to watch. This was followed with the development of their particulate drug delivery systems through the introduction of a new micro fluidic technology. Three months later Medmicro developed the World's first commercial micro plant and targeted growing controlled release and cell therapy sectors with microcapsule technology. Finally, Medmicro appointed a biotech pioneer as a non executive director.

Medsemicon Ltd

Company background

Medsemicon Ltd has considerable expertise in the area of power devices including thermal management aspects and this was crucial to the formation of the company. Medsemicon has been funded as a venture capital company through a large corporation and is chaired by its founder who has established other electronics companies.

The company is using the latest technology in semiconductor light emitting diodes and laser diode devices to develop and manufacture semiconductor based light source systems. Medsemicon has know-how and intellectual property (IP) regarding efficient thermal management techniques enabling heat to be removed for the operation of devices. Optical design technologies are being developed for efficient light coupling from these devices to target application regions.

Research and Development

Medsemicon operates in the four main areas of Smart LED (light engine modules), consumer systems (healthcare devices), industrial systems (non destructive testing and agri-foods) and medical systems (skin treatment devices). In particular areas the company licenses technology to companies who want to utilise IP in products. The IP portfolio reflects investment in R&D and this comprises more than ten pending patent applications. IP applies to many aspects of LED systems technology and these range from novel optical and thermal management technologies to methods of skin treatment using LEDs. The company is small and agile and has strong design skills and LED compatibility in the infra red, visible and ultra-violet wavelengths. An overall manufacturing aim is for customers and there is also the ability to licence IP where potential and volume is high.

There are nine company board members including two university professors (one being the Chairman) a vice chairman, chief executive officer, chief technical officer and an observer. The management team includes the operations manager, systems engineering manager, quality manager, chief technical officer, chief executive officer and LED design manager. The principal investors are a corporation, laser company and University Ventures.

The company is committed to quality management and received ISO 9001:2000 accreditation. Additionally, medical device QMC accreditation ISO 13485:2003 was also achieved. Medsemicon is developing semiconductor based light source modules and systems involving optical design techniques, thermal management and semiconductor optoelectronic device fabrication. The company received venture capital (VC) funding and has subsequently built its product development activity, R&D and management team. The company achieved ISO 900 QMS accreditation.

Conclusions

Principal markets are in the health care and medical sectors and there is an intellectual property base ready to be exploited in other markets. Target markets are the cosmetic and medical sectors and systems are used by medical practitioners and doctors and are being developed for customers. The company is a market leader in the design, development and production of intelligent higher power light emitting diode (LED) light source illumination systems. Product lines combine patent pending thermal management technology with the advantage of LED's as a light source for HI growth applications. The company forms long term strategic partnerships with main players in the market rather than offering products for sale on the open market. By doing this the company focuses on technology delivery for applications using high power LED technology. Prototypes are made to clients' specific requirements and these are taken to volume manufacture through the global sister company that is the manufacturing partner. The mission statement of the company is "to become a global leader in the design and manufacture of advanced LED technology solutions and systems to the medical, industrial and consumer markets". Medsemicon provides cost effective fully integrated systems of LED array solutions to satisfy the requirements of customers. Products developed by Medsemicon include optoelectronic modules and systems. These have been developed using patent pending LED array and optical thermal management technologies and they are targeted at providing high power solutions at lower cost for a spectrum of markets. World class performance is exhibited by the systems developed which are aimed at the aesthetic and healthcare sectors. The ultimate aim is to make the company profitable concerning R&D cash.

Summary/Discussion

Two considerations of major importance to modern governments with regard to the health sector are what will be the policies needed to guide scientific and technological R&D efforts and how to organise programmes and initiatives. It appears that there is a need for selectivity and concentration of resources into those sectors such as health where there is a critical mass of research and resources which have the potential to be developed to a World class level. The current levels of research activity in the sector have the capacity to be developed if the right policy decisions are made. In relation to this potential there are certain R&D requirements in the sector that need to be provided for.

A major policy question concerning R&D is the extent to which indigenous technology progress is created by local R&D or by developments globally (Revesz and Boldeman, 2006). Needless to say the economic impact of R&D on health sector companies will be of considerable importance. Within the health sector there will be a number of methods used by enterprises to protect the competitive advantage of their new or improved processes and products. A major influence on the commitment to R&D programmes by firms in the health sector is to develop intellectual property (IP). Small enterprises in markets will often need patents in order to release new products (Mazzoleni and Nelson, 1998) and this is evidenced through patents being taken out by a small percentage of the companies.

There is an argument that small health businesses will receive most of their technology innovations from other larger companies and with competitive conditions they will have the incentive to adopt exogenous new technologies without government support. Indeed, at a qualitative level there will be the case both pro and ante for R&D government support and quantitative analysis is required to determine R&D subsidies at an optimum level (Revesz and Boldeman, 2006). A number of surveys in the literature have considered time delay and it has been found that time constraints have been identified by health companies as an issue that limits R&D opportunities.

Conclusions

Public schemes for R&D activities can include subsidies for business R&D, research by public bodies (especially universities) and IP protection. In the study of health companies they reported that they undertook R&D in partnership with other companies, universities and the NHS. R&D in universities has the important aim to provide postgraduate students with research skills and related to this public R&D creates considerable knowledge spillovers to business through "tacit" knowledge, training of researchers and collaborative ventures. For the health companies investigated the partnerships companies were involved with included academic research papers, Knowledge Transfer Partnerships (KTPs), consultancies and spin outs. A significant policy question for R&D activity for health sector small companies is to what extent domestic technology progress is influenced by global developments or domestic R&D. In answer to this it appears that domestic technology progress is influenced by both global developments and domestic R&D.

Further Reading

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4 Energy – Sustainable Energy through Research and Development

Gary Packham, Christopher Miller and Brychan Thomas

"Energy is an eternal delight, and he who desires, but acts not, breeds pestilence"

WILLIAM BLAKE (1757–1827)

This chapter at a glance

- Introduction
- The overall energy picture
- Energy sector firms
- Case study approach
- Energy sector company case studies
- Summary/discussion
- Challenges in commercialising sustainable energy research
- Conclusions

Introduction

In recent years it has been reported that UK public funding for energy R&D has declined significantly (IEA, 2000). In fact, from a position during the 1970s and 1980s where annual funding was several hundred million pounds, funding declined to around fifty million pounds a year by 2001 (this represented as little as 10% of the 1980s annual budgets) (Watson and Scott, 2001). Although the decline in funding was similar to other countries the UK situation was severe due to the decline being greater than other member countries of the International Energy Agency (IEA) and due to the fact that the UK budget was aligned with small economies (Denmark, Norway, Spain) instead of leading economies (Germany and France) (Watson and Scott, 2001).

The overall energy picture

As one of the largest sectors of the UK economy, the energy sector accounts for annual sales of around $2,000 billion world wide (SAM, 2002). For the period 2001-2030 total investment for the world wide energy supply infrastructure is estimated to be $16 trillion which shows a considerable increase over the previous thirty year period (IEA, 2003). Environmental and security concerns, together with innovation are leading to primary changes to the industry (Wustenhagen and Boehnke, 2006). The need for sustainable energy is more than evident due to the fact that greater than 80% of electricity generated world wide comes from fossil fuels, which cause global warming, and nuclear energy with hazardous waste and security issues (EIA, 2009). In these terms the identification of sustainable energy programmes as key target areas for efforts to promote sustainable energy research and development (R&D) appears appropriate (BMU, 2005). There is a need to have a clear definition of sustainable energy technologies which are defined by Wustenhagen and Boehnke (2006) "as providing energy services (such as light, heat or mobility) with a lower environmental impact than today, while maintaining economic efficiency (including external costs) and being socially acceptable". For sustainable energy programmes to work there is a need for all the internal and external stakeholders to be participative in order for the benefits to be maximised. The supply of expertise and services by universities in the area of sustainable energy needs to be matched with organisational and industry needs. This chapter therefore focuses on the broader picture of sustainable energy activities in relation to industry requirements by considering appropriate business models.

Energy sector firms

In order to help define the energy sector SIC codes can be used to classify energy sector firms (Table 4.1).

Listing number	Energy sector	SIC code
1.	Coal technology firms	1010
2.	Nuclear power firms	1520, 1610, 2330, 3205
3.	Oil/petroleum firms	1110, 1120, 2320
4.	Liquefied natural gas firms	1300, 1620
5.*	Wind energy firms	4010
6.*	Wave and tidal firms	4010
7.*	Biomass firms	4010
8.*	Solar energy and photovoltaics firms	4010
9.*	Geothermal energy firms	4010
10.*	Hydroelectric power firms	4010

Table 4.1: Energy sector firms SIC codes
* Electricity generation

Energy sector firms can be categorised according to a classification for energy R&D performers (WAC, 2006) as follows:

1. Coal technology firms
2. Nuclear power firms
3. Oil firms
4. Liquefied natural gas firms
5. Wind energy firms
6. Wave and tidal firms
7. Biomass firms
8. Solar energy and photovoltaics firms
9. Geothermal energy firms
10. Hydroelectric power firms

For the classification of energy R&D performers the definition of "R&D" in the energy context has been determined. Accordingly, energy R&D (EIA, 1999) can be categorised as:

1. Basic energy research
   Basic energy research rather than considering particular applications involves advancing scientific knowledge and understanding phenomena.

2. Developing new energy technologies research
   This concerns scientific knowledge that is commercially applicable with known objectives involving research uncertainties and difficulties.
3. Improving existing energy technologies research
   This encompasses the design and testing of new processes using scientific knowledge involving cost and technical uncertainty with the beneficiaries being operators and customers of the improved technology and producers and consumers of particular fuels.

The three categories above can be related to the energy R&D performers as (a) Basic Energy Research and (b) Applied Research and Development including Coal (1), Nuclear power (2), Other fossil energy – Oil (3), Liquefied natural gas (4), Renewable energy, Wind (5), Wave and tidal (6), Biofuels and Biomass (7), Solar energy and photovoltaics (8), Geothermal (9) and Hydroelectric (10).

Case study approach

The use of the case study approach has allowed the findings to be intrinsically linked. This has allowed the results to be interpreted ideographically in terms of the case particulars. Information has not been interpreted nomothetically thus ensuring that there are no law-like generalisations inferred. Since case studies are exploratory in nature and are used in areas where insufficient knowledge exists (Hussey and Hussey, 1997) they are appropriate to the case studies described in this chapter. According to Bryman (1989) case studies are important in terms of offering the researchers the opportunity to test theories, which in the terms of this chapter is the relative importance of internal and external relationships in R&D. This offers a contrasting view to the view that case study research only offers new research data and information. Since the validity of case study findings from particular organisations is often questioned the corroboration of evidence from other sources reduces the doubts that may arise.

In accordance with Yin (1994) the case study approach used for this work has possessed the following characteristics:

1. the research has aimed to understand and explore the phenomena of the relative importance of internal and external relationships in research and development;
2. the research has not necessarily commenced with a set of preconceived questions and ideas in regard to the organisations which have been researched;
3. and the research has used multiple methods to collect the relevant information from the case study sources and the relevant literature.

The main stages of the case study have been followed in accordance with the accepted approach of (a) selecting the cases, (b) preliminary investigations, (c) information gathering, (d) the analysis stage, and (e) the report stage. Also, the research has followed the approach of phenomenological studies to explain patterns from the study (Hussey and Hussey, 1997).

Three case studies have been undertaken in the energy sector and these are reported below according to the company background, research and development and conclusions.

Energy sector company case studies

Ensector Ltd

Company background

Ensector Ltd is a leading UK renewable energy company. They are highly skilled and experienced renewable energy consultants specialising in the design and installation of a range of renewable energy technologies. These include biomass wood energy, hydro, solar and wind. Services to companies include assistance with the implementation of sustainable energy projects, consultancy work, environmental assessments, technical designs, feasibility studies, resource assessments and help to reach 10% on-site renewable generation targets. For these activities Ensector Ltd has the requisite experience and capabilities. Recently the company won a Small Business of the Year Award in 2006 and was a winner for the Queen's Award for Enterprise.

Research and Development

Since Ensector Ltd does not have the resources of the utility companies and the multinationals it has recognised the importance of its own R&D capacity. The company operates in South America, Africa, Asia and Europe and provides power based solutions for a range of renewable energy options. This includes commercial requirements in communities and hospitals in Latin American, African and Asian countries and in the UK. The company's research facility has received funding from ETSU (the DTI's Energy Technology Support Unit), the UK Department for Overseas Development and from Europe. Projects have included heat storage cooking in Nepal which was a three year project to research the ways of maximising the usage of small hydro. This was in remote villages in order to improve living conditions and prevent deforestation. There has been the design and supply of solar powered medical equipment for use with the World Health Organisation (WHO) cold chain development. This has included electronic control equipment, computer power supplies, operating theatre lights, centrifuges, laboratory power supplies, cooling fans, remote lighting and vaccine refrigeration units. Another project has been solar photovoltaic powered reverse osmosis for village use in remote arid regions to develop an economic small scale water treatment plant. A fourth project has researched stream flow monitoring in remote catchments. This resulted in commercial exploitation of the method and the device. These are examples of the capabilities of Ensector Ltd in renewable energy research. With some of the projects they also result in products for the renewables market.

Conclusions

Ensector Ltd has been an innovator for emissions reductions and future energy systems. As such the company invests in R&D for new applications and technologies. These include rural electrification solutions for the developing world, components for photovoltaics (PV), heat storage and electronic equipment, intake screens for hydropower, Geographic Information System (GIS) applications and resource management instrumentation. Consultancy is provided on biofuels, hydrogen and wave/tidal energy and research is being undertaken into exploring the energy systems of the future. The range of specialisms supports the spectrum of renewable energy needs. This includes remote off-grid PV and wind systems, photovoltaic and solar power installation (including integrated systems and PV module supply), wind turbine/wind farm and hydro developers and community renewable energy initiatives. Organisations supported are non-governmental organisations, housing trusts and hospitals, energy service providers, overseas development organisations, research organisations and local authorities. Ensector Ltd, therefore, has the experience and knowledge to support projects regarding renewable energy needs both cost effectively and efficiently from the inception to installation. Clearly R&D features as a central and important function in the operation of the company.

Enrenew Ltd

Company background

Enrenew Ltd is a renewable energy company who are involved in the use of innovative renewable technology to help in the realisation of more environmentally conscious renewable resources on both a small and large scale. Key services include project management, monitoring services, consultancy and advice on energy saving, sizing of renewable energy systems, feasibility studies on renewable energy power supply projects and energy and environmental auditing. Enrenew Ltd has been working in the field of renewable energy since it began trading in 2000. The company works with the development of innovative renewable energy technology and the aim is to develop as a trader of products and services in the short term and to carry out work related to the manufacturing of renewable energy systems and development of renewable energy projects in the long term. With the growth of the company the emphasis will remain on the development of innovative ideas in the field of renewable energy and through new ideas in the growing global market of energy production.

Research and Development

In the area of R&D Enrenew Ltd is involved in a wide range of renewable energy and sustainability services. They are able to provide a complete service through the stages of wind turbine sizing, research, supply and installation. Through their links with wind manufacturers, services are provided with full environmental and financial diagnosis at a competitive cost. The company has considerable experience in producing planning documents for a number of wind farms and single wind turbines and in designing wind farms. Feasibility studies are conducted on renewable energy projects for export or on-site use. Studies consider which type of unit to use, the payback period to determine the suitability of a system, the cost of installing the system and the power use of the unit. Studies range in scale from large industrial plant to local farmhouses. Depending on the user's need studies can be undertaken providing a variation of detail. For houses and businesses investigating the utilisation of biomass systems, solar and wind for energy production site visits can be undertaken by Enrenew Ltd. Energy requirements and use will be calculated following a site visit with advice provided on the type and size of system appropriate. The company also provides an optional service with supply and pricing information. Through this service customers have the system provided at competitive cost following information being provided about the types of renewable energy systems suitable to their requirements.

It is usually best to minimise energy wastage from a financial and environmental perspective as well as offsetting energy use through renewable energy use. The waste of available energy is a common problem of westernised society and there is a need to reduce this impact. Major energy losses will often occur in those areas which can be easily corrected and are elementary. Indeed, an Energy Agency in a recent survey found that firms could save at least 30% of their energy use and consequently 30% of the costs. Energy saving measures will be low cost or no cost options. As a consequence Enrenew Ltd can provide consultancy and advice on energy saving.

In the area of energy and environmental auditing Enrenew Ltd provide a range of research and consultancy services for both large and small organisations and companies. These organisations will want to reduce their energy costs and to have an environmental policy. In order to assess the annual usage of energy, audits can be carried out on site and will identify areas where there is the potential for a reduction in energy waste. This will be either through investing in renewable energy technology or through increased energy efficiency. Enrenew staff who undertake the audits are experienced in the areas of renewable energy and energy efficiency. Detailed advice can be offered on those technological changes that are necessary. An example of this type of survey is one that has been undertaken for the University Student's Union buildings.

Site surveys are carried out by Enrenew by monitoring wind characteristics for wind turbine installation. Over a 12 month period wind monitoring equipment will be set up and monitored constantly. This will enable the calculation of the annual mean and seasonal variation. Through the use of a transferable weather resistant computer chip information can be transferred to a personal computer in the office for statistical and graphical analysis.

Conclusions

During the six years since Enrenew Ltd has been established the company has been involved with a number of renewable energy installations throughout the UK for residential customers and businesses. There has been involvement with large and small scale combined wind and solar PV remote installations, wind monitoring, solar hot water and wind. As well as these projects Enrenew Ltd have been able to undertake site work including hands on installations and surveys. Similar to Ensector Ltd, Enrenew Ltd considers the R&D function as a central and important activity in the operation of the company.

Encost Ltd

Company background

When Encost Ltd was launched as a spinout company from a university the focus of the company was to reduce utility costs and to provide customised online utility information regarding these costs and to ensure that they remain low. The company works with customers to provide a full energy/utility service ranging from fuel purchasing, meter installation, advanced monitoring and targeting to project engineering and information technology (IT) solutions. In addition to IT and software developments Encost Ltd undertakes remote analysis of customers' consumption patterns and works closely with clients to achieve reduced costs. The company aims to be a professional service provider by establishing trust through building personal relationships. Through this trust it enables Encost Ltd to work with customers, employing the most appropriate technology to gain outstanding results. The products and services provided include metering hardware and connectivity; IT support, hosting, VDN and networking; installation of metering hardware and network cabling; installation of gas, water and steam meters; Web design, Web development and consultancy.

Research and Development

The reasons why customers have chosen Encost Ltd for their energy system requirements are because they have energy bills over £100,000, require a Climate Change Levy (CCL) rebate, have experienced a large rise in energy bills, want to improve their "bottom line" for little capital outlay and are concerned about the environment. Additionally, technical reasons for choosing Encost Ltd include their unique and advanced .Net Web management system, advanced statistical process control and proactive alarming, secure Virtual Private Network (VPN) data connectivity to each company, customisable reporting and visualisation and an exceptional range of business patterns and support. Also, the company is one of the few organisations that offer a full energy management service remotely. So far there have been four pilot customers.

Office space was provided at the University spin-off premises with the help of the University commercial company. The two founders were both employed by the University in the Technology School and are the two directors of the company. Office space, support staff and facilities have been provided in the School as well as the University spin-off premises. The company is being developed within the University's Technology School.

Conclusions

When the company commenced trading it was involved in remote utilities monitoring and management which is a sophisticated system developed from proof of concept. As well as the co-founders, who are directors there is a technologist employed under the Knowledge Exploitation Fund (KEF). Encost Ltd undertakes work for companies with large energy bills (£1m+ per annum) and reduces energy use by up to 20% per year. The four test sites where this technology has been applied include two private manufacturing companies, a public body (hospital) and a leisure organisation (hotel). R&D is seen as an important support function to the company for it to stay at the forefront of energy management systems technologies.

Summary/Discussion

In this chapter R&D activity in specific companies has been investigated in terms of the mechanisms and processes by which it takes place. A case study methodology has been used to examine these processes and three case studies have been undertaken in the energy sector. The findings of the case study research have been analysed in terms of the R&D activities of the businesses according to demand, organisation, innovation, imitation and diffusion, complementary assets, networking and government influences on business R&D. The literature has identified demand as being important in terms of the motivation to undertake R&D (Crespi et al, 2003). This is demonstrated by two of the case study companies in the energy sector (Enrenew Ltd, Encost Ltd).

According to von Tunzelmann (1995) R&D augments the four main functions of productive units (administration and finance, products, production processes and technology). This is illustrated in the case study companies since they see R&D as an important activity in the operation of the company. Rather than only demonstrating absorptive capacity (Cohen and Levinthal, 1989, 1990) the case study companies appear to be innovative in their work. This is shown by Ensector Ltd as an innovator for emissions reductions and future energy systems. The company invests in R&D for new applications and technologies. Enrenew Ltd is also involved in the use of innovative renewable energy technology and detailed advice is offered on technological changes. In addition, Encost Ltd works with customers, employing the most appropriate technology to gain results.

As well as the ability of R&D to create new products and processes it will depend on the other resources and functions within and outside the company which Teece (1986) has called complementary assets. An example of this is Ensector Ltd who do not have the resources of the utility companies and the multinationals and have recognised the importance of their own R&D capacity. Further to complementary assets other sources external to the company can be acquired through networking and this can involve Higher Education Institutions (HEIs) (von Tunzelmann, 2004) and government in what Etzkowitz and Leydesdorff (2002) have called the triple helix. In order to provide a professional service a company can establish trust through building personal relationships involving networking. One of the case study companies that has done this is Encost Ltd.

Finally, there are a number of ways government activities can influence business R&D and these include research funding, industrial R&D finance and through intellectual property rights (IPR). For example, Ensector Ltd's research facility has received funding from ETSU (the DTI's Energy Technology Support Unit), the UK Department for Overseas Development and from Europe. Another example is Encost Ltd who have received funding from the Knowledge Exploitation Fund (KEF) to employ a research technologist.

The above summary/discussion provides illustrative examples of R&D activities of the case study businesses. Through these activities it is shown that R&D is an important function for firms in the energy sector.

Challenges in commercialising sustainable energy research

It is apparent that sustainable energy technologies, for example heat pumps, solar cells and solar collectors (Dunn, 2000), deploy renewable and non renewable fuels to generate energy/heat at lower environmental impact than conventional energy technologies (Wustenhagen and Boehnke, 2006). The move from conventional to sustainable energy although perhaps resulting in a lower cost for society does not necessarily mean a lower cost to consumer (Wustenhagen and Boehnke, 2006). Such a discrepancy between public/private benefit/cost can be a major problem when making decisions regarding sustainable energy research (Wustenhagen and Teppo, 2006). Similarly, sustainable energy developments involve both public and private benefits (Villiger et al, 2000).

The development of sustainable energy research involves considerable time and resources which is characterised by high capital costs and long lead times (Wustenhagen and Boehnke, 2006). For example, developing a new sustainable energy device requires considerable investment in R&D. Therefore finding funding for new sustainable energy technologies can be challenging (Wustenhagen and Teppo, 2006).

Due to the capital nature of sustainable energy R&D large amounts of resource will have been invested in research infrastructure by existing energy research centres. Therefore those centres that control these assets will have a strong position and may be reluctant to participate in any structural re-orientation that can affect their existing activities. This may pose a serious challenge in setting up a workable Sustainable Energy programme involving small energy companies.

The business model in recent years has become a popular concept in management theory and practice (Magretta, 2002; Chesbrough and Rosenbloom, 2002; Osterwalder et al, 2005; Shafer et al, 2005). A business model can be defined as "a description of planned or an existing business and its specific characteristics with respect to value creation on the one hand and market orientation on the other hand" (Stahler, 2001; Hedman and Kalling, 2003; Osterwalder et al, 2005; Wustenhagen and Boehnke, 2006). In these terms the business model combines the resource-based and market-based view of the organisation and takes an integrated viewpoint (Kalling, 2002; Morris et al, 2005). Management practice has emphasised the importance of business models (Morris et al, 2005) and although much research has attempted to analyse the business model concept there is no accepted definition by academics (Osterwalder et al, 2005; Porter, 2001; Shafer et al, 2005) and practitioners (Linder and Cantrell, 2000) alike. Academics agree that the business model elucidates how a business creates value and is an important unit of analysis relevant to both management theory and practice (Chesbrough and Rosenbloom, 2002; Rentmeister and Klein, 2003; Belz and Bieger, 2004; Morris et al, 2005). Therefore, the analysis of the business model can aid understanding and communication of key success factors of value creation. Moreover, it can measure, compare and change business logic (Morris et al, 2005; Osterwalder et al, 2005; Shafer et al, 2005).

Among the first to propose a formalised definition of a business model, Timmers (1998) viewed it as a description of the architecture of value creation, potential value generated for partners, sources of revenue and marketing strategy. Following this a further definition by Hamel (2000) noted the four business model components of core strategy, strategic resources, customer interface and value network. In this chapter we have followed the definition of Stahler (2001) describing a business model as a description of a planned or existing business including the three elements: value proposition, configuration of value creation and revenue model. Value proposition describes how products and services offered by the organisation create value for the stakeholders. Configuration of value creation describes steps of the value chain performed by the organisation and an organisation will develop core competences by which it can be identified. The revenue model describes how the organisation generates revenue.

By designing the three elements of the business model described above a small energy company can tune its offering to meet the three challenges of sustainable energy research and achieve higher penetration of the resultant technologies as well as commercial success. With the value proposition sustainable energy technologies are characterised with the component of public benefit and pose a challenge to convince users to adopt them rather than other energy technologies with a stronger private benefit. By highlighting the private benefit on top of the public benefit a sustainable energy development will attract a larger set of users (Villiger et al, 2000). Configuration of value creation which is properly designed can help to address the barriers of capital intensity and the power of incumbents by focussing on those components that are key. Innovative revenue models are at the core of success for a Sustainable Energy business model and are important for sustainable energy R&D. This will involve not just the development of sustainable energy technologies but also a comprehensive technical service to underpin these. How the business model configuration addresses the challenges in commercialising the activities of Sustainable Energy is shown in Figure 4.1.

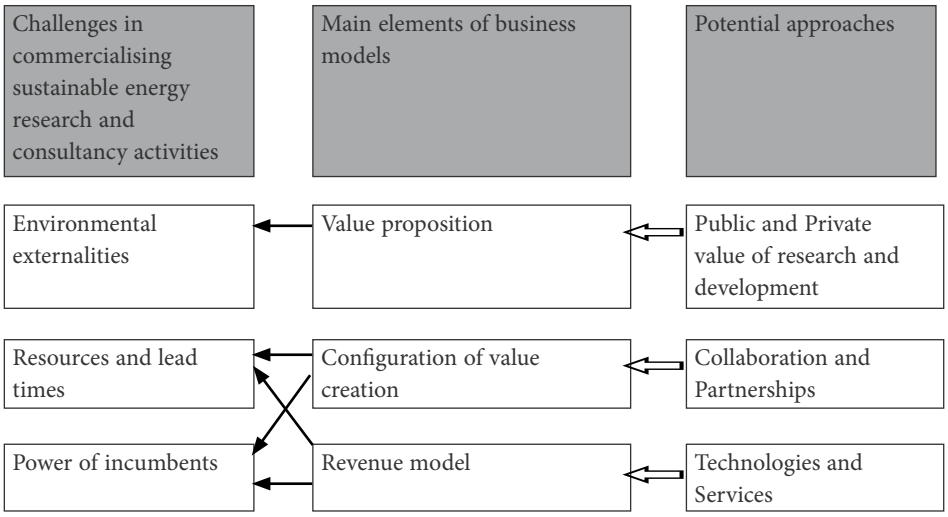

Figure 4.1: How the Sustainable Energy business model configuration addresses the challenges in commercialising research and consultancy activities (based on Wustenhagen and Boehnke, 2006)

Conclusions

An appropriately designed Sustainable Energy business model provides the opportunity to overcome key barriers to commercialising sustainable energy research and development for small energy companies. By focussing the value proposition on creating high private value as well as public value provides a means to address the challenges arising from environmental externalities. Through configuration of value creation to provide for efficient use of resources and making use of collaboration and partnerships can help mitigate the barriers to undertake Sustainable Energy research. Through collaborative agreements and partnership networks it is possible to work with both internal and external established stakeholders and to address the power of incumbents. Innovative revenue models will enable Sustainable Energy research to be undertaken by small energy companies to maximise their activities.

Further Reading

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5 Construction – Innovation, Technology and Small Construction Enterprises

Christopher Miller, David Pickernell, Brychan Thomas and Gary Packham

> *"Before I put a sketch to paper, the whole idea is worked out mentally. In my mind I change the construction, make improvements, and even operate the device"*
>
> NIKOLA TESLA (1856–1943)

This chapter at a glance

- Introduction
- Small Construction Enterprises and Technological Development
- Innovation
- Technology
- Key success factors
- Conclusions

Introduction

Based on the volume of production and the proportion of total production and employment, the construction industry must rate historically as one of the most important economic sectors in Europe (Rainbird and Syben, 1991). Construction is often dependent upon a strong economy to stimulate activity, as major works are rarely undertaken in periods of recession. Government economic policy can either stimulate or depress the work available within the industry (Harvey and Ashworth, 1998). There can be no doubt that construction is an important activity in the regeneration of any economy.

Organisational structures and work methods within the UK construction industry have shown significant change in recent times (Yisa and Edwards, 2002). This has been through a shift towards specialisation and flexible work relationships (Chinowsky, 2000). Rigid corporate hierarchies, fixed procedures and departmental boundaries of large corporations have evolved into more flexible business structures (Anderson, 1997; Morgan 1995). It is recognised that organisational competence is important for the achievement of competitive advantage (Moavenzadeh, 1995).

The construction industry historically has used contractual arrangements and this encouraged clients and contractors to see themselves from an adversarial point of view (Ball, 1988; Bresnen, 1990). More recently the industry has continued to be influenced by project time and cost overruns and client dissatisfaction despite less adversarial and new alternative contractual arrangements (Egan, 1998; Latham, 1994). A major contributor to these problems is the fragmentation and division of labour between professionals and other members of the client's team including contractors and their suppliers/subcontractors (Hillebrandt and Canon, 1990; Yisa et al, 1996).

Small Construction Enterprises and Technological Development

The construction industry has historically placed emphasis upon the increase of technologies and processes throughout the supply chain for Small Construction Enterprises (SCEs) (Abbott et al, 2006; Barrett et al, 2008). Many reports have questioned the industry's ability to provide products/services that meet the clients' needs. The industry has been criticised by many in regard to the take up of new technologies, processes, organisational issues and reversing the adversarial culture (Central Council for Works and Buildings 1944; Emmerson Report 1962; Latham Report 1994; Small Business Research and Consultancy 1996; South Glam. TEC Report 1996; Egan Report 1998).

Construction technology can be defined as the combination of construction methods, construction resources, work tasks, and project influences that define the manner of performing a construction operation (Laborde and Sanvido, 1994; Fairclough, 2002). Innovation can be defined in many ways depending on the context in which it is used. Within the construction process it is deemed to be relevant to define innovation as the first use of a technology within a construction firm (Laborde and Sanvido, 1994; Fairclough, 2002). Technologies can be defined as the use of current knowledge in order that goods and services are produced (Ofori, 1994). The definition covers equipment, tools, techniques, materials, systems, processes, information and the goods or services produced, and their use (Ofori, 1994).

The transfer of technologies has been implemented successfully within the construction industry in countries such as Japan (Kangari and Miyatake, 1997) but has tended to be slow. The changes that have been made in the UK have been implemented in an incremental fashion, and are often not at the necessary pace required by the environment in which the industry operates (Kale and Arditi, 1998). It is perhaps opportune that the last decade has offered stability and a profusion of work to the industry.

Sociologists have viewed technological change as theoretically impossible to describe, as it is embedded in the socially created nature of the process. Alternatively, Tidd et al (1998) argue that a firm's capability to take up technologies and processes is embedded in its knowledge base. The knowledge and trust base of firms must be understood in terms of change. The precise nature of change tends to differ from firm to firm, due to their unique characteristics (Williamson, 1975).

Major changes in markets, technologies and the degree of competition enforce the need for organisations to change in terms of management and organisational capability. Technological and process change within organisations is the result of many management decisions regarding the purpose of the organisation. People are organised to fulfil the purpose of change decided by management (Thompson, 1996). The implication is that we should not be studying technology but instead be investigating the perceptions, motivations, aspirations and decision making process of the owner manager. Technological and process change within organisations is difficult to implement, in that enterprises do not alter management styles and structures in an incremental and smooth fashion. Change is usually forced upon organisations via macro environmental uncertainty.

Innovation

Innovation is defined as 'generation, acceptance and implementation of new ideas, processes, products or services' (Thompson, 1965, p. 35) or the 'successful implementation of creative ideas within an organization' (Amabile et al., 1996, p. 25). It can also be defined 'as the actual use of nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change' (Slaughter, 1998, p. 226) or simply 'the process of bringing in new methods and ideas or making changes' (Atkin and Pothecary, 1994, p. 55). Similarly, it is suggested that innovation 'is the act of introducing and using new ideas, technologies, products and/or processes aimed at solving problems, viewing things differently, improving efficiency, or enhancing standards of living' (CERF, 2000). In contrast, Kimberly (1981, pp. 84–5) brings attention to (the value neutrality of many definitions of innovation) by noting that 'innovation tends to be viewed in unreflective positive terms…[and that]…for the most part, researchers have assumed that innovation is good'. This assumption hampers an appreciation that innovation is associated with uncertainty and risk of failure (Sexton and Barrett, 2003a&b). Innovation 'holds out the hope of large rewards but also the possibility of expensive failure. It usually requires significant resources, either alone or with others, or a privileged position' (Goffin and Mitchell, 2005, p. 127). It must be understood, therefore, that implementing innovation warrants extremely careful planning, strong leadership, continuous assessment and adaptability in order to be successful and sustainable.

In the construction literature, Blayse and Manley (2004) see innovation as necessary through enhanced technological capability, operational improvements, and the improved image for technical progressiveness that follows from this. Thomas and Bone (2000, p. 67) identify several key areas for innovation activity that 'can deliver significantly improved quality and value': partnering and supply chain management and partnering, technical innovation and sustainable value/risk management. Another way to look at this is in terms of *management* and *relationships* with customers and through the supply chain, *technological* innovation in processes, products, and skills.

Technology

The planning and logistical integration throughout the supply chain network also requires a centralised co-ordination of key data (drawings, specifications, instructions, order forecasts, production plans and delivery schedules) (Muhamed, 2003). By electronically linking and transferring the vast volumes of project related data (created; transmitted; and archived), to and from dispersedly located project participants (clients, architects, contractors, consultants, etc.), Information and Communication Technology (ICT) systems will potentially (Weippert et al, 2003):

1. allow seamless collaboration between project consortiums;
2. promote rapid resolution of ongoing project issues by decreasing response times;
3. and reduce the need for unnecessary travel time and cost overruns.
4. Additionally, project communication and information "leaks", losses or misplacements would be kept to an absolute minimum,
5. and all members of the project consortia would be in possession of the most up-to-date and accurate project information.

The rate at which knowledge is being created has also accelerated and there are numerous examples of where new technologies are having a major influence on markets (Goffin and Mitchell, 2005, p. 2). The possibilities for the future of the construction industry are also promising. Various technological programmes have been initiated with the primary objective of re-engineering operations and processes in the construction industry (Sing and Zhong, 2001). These programmes are developing ICT systems (Sing and Zhong, 2001; Muhamed, 2003) that complement the development of Internet-based Construction Project Management (ICPM) (Weippert et al, 2003) or Web-based Project Management (WPM). Project information on these systems have included documents, technical drawings, specifications, meeting minutes, cost reports, visual images and workflow correspondence such as requests for information and site instructions (Muhamed, 2003). Logistics will also be revolutionized by RFID technology – radio frequency identification labels – which automatically transmit information about the nature and location of articles (Goffin and Mitchell, 2005, p. 2). Widespread use of these integrated databases will assist in the resolution of the industry's current communication and coordination predicament. Furthermore, the use of new computer technologies will form a familiarity link with technology which will facilitate the integration and diffusion of other such innovations.

It is hoped that, with the use of information technology (IT), a high level of efficiency, productivity and quality can be achieved in every segment of the development lifecycle of a construction project (Sing and Zhong, 2001). The type of IT implemented will depend on the people that use it, and the extent of its use will depend on the culture of the organisation and/or industry as a whole (Aouad et al, 1999). If current levels of international research activities are any guide, improved information sharing and increased use of innovative ICT tools and Internet-based construction project management (ICPM) systems are seen by many industry members as a potential solution to ensure large improvements in the communication efficiency, productivity and overall industry quality (Howell, 1996).

There are also many examples of new product technology in construction (e.g. solar heating, etc.). More holistically perhaps innovations in prefabrication have the potential to alter the construction industry in fundamental ways. Prefabrication itself is not new, having first surfaced in construction in the early 1900s, when it was referred to as the "Henry Ford of housing" (Miles, 1996). Prefabrication of the mid-20th century, however. was viewed as limiting and was rejected by architects and clients. In response to the challenge of providing new housing within a short time frame the new breed of instant homes, erected from panels or as modular units, come straight from the production line to the building site with whole sections of houses incorporating everything from the kitchen sink to tiling, plumbing and bathrooms. Computer technologies are allowing for a higher degree of accuracy and thus higher quality components, enabling off-site fabricators to produce higher-quality housing than on-site construction teams can (Murdock, 2005). Construction time can be cut by two thirds (Steele and Todd, 2004) by drastically reducing on-site activities in construction (Koskela, 2003), as well as reducing waste, and improving site safety by providing a cleaner and tidier site environment and elimination of site malpractices (Ho, 2001).

Key success factors

The potential barriers to success are thus varied, interlinked and entrenched. The challenge for innovative organizations is getting people to pay attention to the creation of new ideas instead of the protection of existing practices (Sexton and Barrett, 2003a&b). A variety of strategies will need to be utilised to overcome them, depending on the issues at hand. For innovation within the construction industry to have the opportunity to succeed, the lack of senior management commitment, the lack of appropriate support structures, the pessimistic workplace culture and the widespread ignorance of supply chain philosophy must be addressed (Humphreys et al, 2003) and building virtual organisations within the supply chain to provide a complete service which is efficient, creative and innovative (RCF, 1995) is essential. Miller *et al* (2004) state, that; 'distance and self-interest inhibit effective inter-organisation relations' (p. 21) and set out the 'Challenge for Wales and its Construction Industry', namely:

1. Acknowledge the pivotal role of SCEs in the construction process,
2. Develop training initiatives that are beneficial to SCEs, and
3. Engender a more inclusive construction culture that meets the needs of contracting parties and aspires to the notion of increased profitability for all.

This also highlights the importance of considering the role of SCEs within the overall framework of stakeholders in the construction industry. Carrie (1999:45:50), for example, believes a crucial consideration is recognition of the 'interdependence of all the stakeholders in the economic infrastructure of their part of the world'. Stakeholders have been described as "any person or organization that has a legitimate interest in a project or entity" (Wales, 2001) and "all the people or groups whose lives or environment are affected by the project" (Walker et al, 2000). That includes not only those directly involved but also those indirectly impacted by production or the structure itself such as the local community or environment (Wales, 2001). In terms of innovation generation, conventional processes for fostering innovation generally have centred on the establishment of specialised publicly funded research institutions, limited and contested higher education funding and internal industry Research and Development (R&D) Units. These highly individualised and competitive approaches have given way to an understanding that successful innovation is the result of cooperative, interactive processes between collectives of key stakeholders, rather than the province of individuals or separate organisations, including government. Indeed, a growing body of research has demonstrated that successful innovation is the result of partnerships or a team effort between a collective of industry players (Anderson and Manseau, 1999; Miozzo and Dewick, 2002).

This, as well as the previous literature suggests a key importance for government, industry and institutional stakeholders, both in demand and supply terms, and the management of their relationships. For some time, studies of innovation processes have stressed the importance of networks to successful innovation, over-turning the traditional model which characterises innovation as a linear sequence running from basic research, through product development, to production and marketing. Innovation is now seen as an interactive process requiring intense traffic in facts, ideas and reputational information within and beyond the firm. In particular, current paradigms in research and development emphasise the need for multi-disciplinary and interactive knowledge production between universities, research institutions and relevant industries, described elsewhere as the 'triple helix model' (Leydesdorff, 2000). The porous nature of the boundaries between these sectors allows for enhanced information, knowledge resource and people transfer, results in the formation of a new innovation location or domain occurring the point at which these three sectors overlap.

As a consequence, increasingly over the past decade cooperative and collaborative research and development arrangements based on the formation of inter-organisational networks have emerged as key strategies to meet these challenges, dissolve organisational barriers and in doing so, foster the development and uptake of innovative techniques and practices necessary to raise the performance of various sectors, including the construction arena (Powell, Koput and Smith-Doer, 1996; Swan, Scarbrough and Robertson, 2003).

The issue of effective networking also extends to the diffusion of the resultant innovative advances. According to Miller et al (2002:3), 'within the construction arena, small firms have had to ensure that the interface between contractors and their own firm is effectively managed'. Contractors are, for example, the customers of other small construction firms. In the 'Rethinking Construction report', Sir John Egan, stated that 'mutual co-operation also allowed participants to augment their expertise' (Egan, 1998). Technology transfer networks are one of the best forums for SCEs to learn from each other, to exchange experiences, and to diffuse technology. Typical areas where the benefits of "good practice" can be found are technology transfer skills (determining an SCE's needs through contracts, agreements and auditing), know-how and technological expertise (concerning construction standards and regulatory issues), the provision of services, and public relations involving management and the organisation (Commission of the European Communities, 1998).

The conceptual framework for innovation management in SCEs thus needs to include the generation process through the interaction of key stakeholders (industry, government and institutions), innovation enabling via the use of effective education and training, fora and conduits, as well as management of networks and their constituents, and diffusion to innovative SCEs and the industry more generally.

Many complementary factors will be prominent and an SCE may be retarded in its acquisition of technology by other SCEs who are slow to adopt the innovation. The role of the technology transfer networks thus becomes critical in reducing the probability of this occurring. The implications for policy of the conceptual framework for innovation management in the construction industry in Figure 5.1, highlights the specific need to develop policy actions in the three interrelated areas under the heading of innovation enablers. Once SCEs comprehend the possible benefits of technology transfer they will need help to realise the benefits, in terms of relevant education and training to take advantage of the innovations. Appropriate fora also require establishment and support, to foster technological knowledge and establish network links from external sources, as do conduits for knowledge and technology transfer (newsletters and databases, R&D audits, financial guidance, etc.). Appropriate management processes, particularly of innovation and creation networks, are also vital. The conceptual framework thus illustrates that the successful diffusion of a new technology involves considerably more than technical competence.

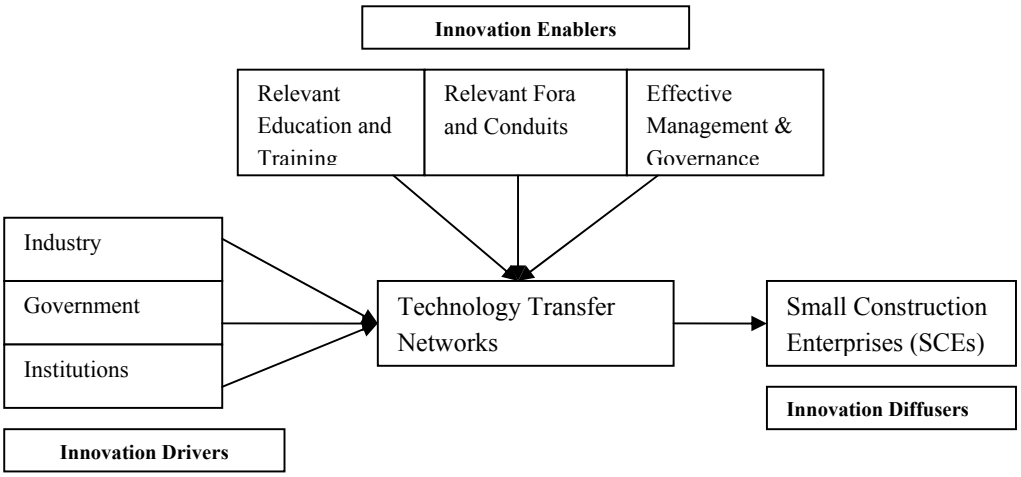

Figure 5.1: A Conceptual Framework for Innovation Management in the Construction Industry

In order to effectively operationalise the framework there is clearly a general need to improve the ability of construction firms in innovation management. Technological innovations such as machinery and some new materials are relatively easy to implement into the construction industry, because the benefits from these innovations can be predicted and their ability to go through a trial assessment is, in general, reasonably quick and straightforward. Once the innovations are shown to be significantly beneficial, where value is being added faster than cost, the innovations will usually diffuse to other industry players in a fairly rapid fashion. This is not the case generally, however and the development of a specific innovation within a firm often requires an innovation champion who envisions and motivates others to either positively buy into the idea or at least allow it safe passage (Sexton and Barrett, 2003a&b).

Innovation implementation within a system of firms however, as within a construction supply chain for example, requires a comprehensive system integrator, or innovation leader (Goffin and Mitchell, 2005, p. 255). Unfortunately, the traditional construction process typically has two separate systems integrators, at design and construction stages, neither of which have the ability to carry out the role in its entirety (Winch, 1998). This can effectively cloud the innovative vision and consequently impede the innovative process (Ireland, 2004). The innovation integrator will effectively manage the relationships between the separate elements of the construction network in order to reduce confrontation and non-value activities, initiate effective scheduling and procurement, and generally increase system efficiency and profit margins. This requirement extends to the need to manage the networks of co-joint industry, and academic innovation centres that are increasingly being supported by governments through new policy initiatives, novel public co-financing processes, and new institutional arrangements that blend competitive and cooperative agendas and relations.

Conclusions

The evidence already presented clearly indicates a need for general training resources to enable construction industry innovation to take place. It is clear that most of the qualifications held by the construction workforce more generally are in manual craft skills, especially in small construction enterprises. Published survey results also identify a significant section of the workforce that has no formally recognized skills whatsoever (Briscoe et al, 2001). There is therefore a need to address this lack of basic enterprise management skills and training to initiate a change in thinking. Another (simultaneous) mechanism for introducing such change is the education of the construction workforce in terms of managerial skills, such as developing communication skills, knowledge of other organisations operating in the construction supply chain and the potential benefits of innovations such as partnering (Humphreys et al, 2003). Bushnell (1998) states: "There is nothing worse than trying to train for a technology when employees do not really understand or fear the concepts that it supports. And there is nothing worse than managers pursuing a concept when they do not understand the importance of, or the difficulties related to, the technology on which the concept depends."

A specific set of skills, however, are also needed to successfully implement sustainable innovation. Innovation management often requires managers to match 'technical' expertise, in areas such as technology and project management, with 'soft' skills in people management, to promote creativity. Few managers have been educated in both of these areas (Goffin and Mitchell, 2005, p. 27). Generally, the type of innovation discussed emphasises relationships between supply chain partners and social interaction becomes important in reducing distrust and uncertainty between parties. It also requires a high investment in skills that can be applied in a teamwork setting (Briscoe et al, 2001). There is also a high premium on good information flows and communication structures between parties in the supply network (New and Ramsay, 1997). These CIT programs will be the backbone of the supply chain communication line.

The literature indicates that utilisation of innovations in new products, services and processes is inherently uncertain and thus dealing with risk and uncertainty is central to innovation management. Encouraging take-up through education and training will therefore involve all parties being provided with knowledge about the innovation itself, and to be inspired and convinced of the possibilities for success (Goffin and Mitchell, 2005, p. 62). The management of innovation thus requires a distinct mix of skills, which will require training.

Sharing good training practices to raise skills will ensure that more contractors can secure a share of major projects (ConstructionSkills, 2005).

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6 Museums and Small Memory Institutions – Multimedia Knowledge Management Systems

Simon Thomas, Lisa Powell and Brychan Thomas

"How does one measure the success of a museum?"

PAUL GETTY (1932–2003)

This chapter at a glance

- Introduction
- Knowledge Management
- Knowledge Management Trends
- Multimedia Knowledge Management Systems
- Global Marketability
- Museum Networks
- Conclusions

Introduction

The chapter considers the diffusion of multimedia knowledge management (KM) systems into global museum markets at the level of the small museum and small memory institution (SMI). Diffusion in the form of multimedia technology, the transmission of knowledge and technological expertise is investigated. This involves technology transfer through formal and informal networks enabling learning by interacting and an absorptive capacity to assimilate multimedia technology. The diffusion of multimedia KM systems is considered including external sources, channels of technology transfer, and mechanisms involved in the transfer of the technology into the innovative SMI. This is related to museum networks in terms of the adoption of multimedia KM systems by SMIs.

The attractiveness of regional networks of less-famous memory institutions (MIs) to improve their socio-economic role can be achieved through advanced interactive multimedia solutions. MIs include museums and museums networks, libraries, archives and parks which have a key role in the socio-economic welfare of European countries (Memoria, 2000). There is no doubt that "memory institutions" (MIs) play a major role in the socio-economic welfare of European regions through stimulating cultural tourism involving destination centres such as hotels, hospitality enterprises, museums, agri-tourist attractions, leisure areas and sporting facilities. This sector is one of the fastest growing income generators across Europe. Indeed, one of the core issues faced by MIs is the wide offering of experiences provided by visitor attractions in their areas. This is leading to considerable potential for competition involving multiplex cinemas, digital media entertainment centres, adventure travel locations and theme park estates, for example.

The main technological and non-technological objectives of advanced interactive multimedia solutions can be stated as: (1) the integration and dissemination of innovative modular solutions for collections management and user access in MIs; (2) the deployment of core territorial services infrastructures supporting MIs and (3) the transfer into MIs of advanced knowledge management techniques.

Global market opportunities can be assessed taking into account SMIs. In relation to this, according to Reed (1992), small museums in the United States (US) had five or fewer full time staff and an operating budget of less than £150,000. The number of museums by type in England is shown in Table 6.1.

Type of Museum	Number
Central Government funded	65
Local Authority	608
Government Agency	53
Higher Education	93
Independent – owned by charitable trusts	855
Private	164
Other	114
Total	1,952

Table 6.1: Number of Museums by type in England in 2005 Source: Museums Association (2006)

According to Table 6.1 there were 1,952 museums in England in 2005, including small museums, of which 53 were Government Agency, including 48 English Heritage museums, and 855 independently owned by charitable trusts, including 52 owned by the National Trust. Table 6.2 shows the number of museums in the Museums and Libraries Association (MLA) accreditation scheme in 2009.

Country	Number of Museums
England	1,393
Wales	85
Scotland	279
Northern Ireland	38
Total number of museums in the MLA Accreditation Scheme	1,795

Table 6.2: Number of museums in the Museums and Libraries Association (MLA) Accreditation Scheme in 2009 Source: Museum and Libraries Association (MLA) March (2009)

In Table 6.2 England has the most museums in the MLA accreditation scheme with 1,393 followed by Scotland with 279, Wales with 85 and Northern Ireland with 38. The top ten most visited large museums in England in 2008 are shown in Table 6.3.

Museum	Visitor numbers
British Museum	5,930,000
Tate Modern	4,862,581
National Gallery	4,207,677
Natural History Museum	3,260,731
Science Museum	2,705,677
Victoria and Albert Museum	2,420,815
National Portrait Gallery	1,843,266
Tate Britain	1,618,309
British Library Exhibition Galleries	1,255,832
Tate Liverpool	1,088,504

Table 6.3: The top ten most visited museums in England in 2008 Source: VisitEngland (2009)

The visitor numbers to the top ten most visited large museums in England in 2008 varied between 1,088,504 to the Tate Liverpool to 5,930,000 to the British Museum.

A more recent definition for a small museum is given by Gee (2001) who defines these in the United Kingdom (UK) as those with two or less paid staff and turnover of under £80,000 per annum. These include local and community museums which appear to have the same status as "regional hubs, designated and university museums and national museums – they appear to be all equal partners although, of course, some are more equal than others" (Gee, 2001). The definition adopted for SMIs in this chapter is the UK definition of two or less staff and turnover of under £80,000 per annum. The diffusion of multimedia KM systems with regard to SMIs has been elaborated in terms of technology diffusion and museum networks.

Museum networks are one of the best forums for SMIs to learn from each other, to exchange experiences, and to diffuse multimedia technology. Areas where the benefits of "good practice" can be found are technology transfer skills, technological expertise and know-how (Commission of the European Communities, 1998). "Good practice" procedures for the diffusion of multimedia technology within museum networks will include software standards for the SMIs, appropriate funding, software performance and confidentiality agreements. SMIs' socio economic forces will have an important role to play. The rate of adoption of multimedia technology will be faster if it is compatible with previous experience and software use and the present normative values of SMIs.

The complementary nature of entrepreneurship and innovation for SMIs will be similar for entrepreneurship and SMEs in general (Zhao, 2005) in terms of internationalisation and the management factors involved (Suárez-Ortega and Alamo-Vera, 2005). As Johnson (2001) reports "entrepreneurship in its narrowest sense, involves capturing ideas, converting them into products and, or services and then building a venture to take the product to market". This will especially be the case for entrepreneurship in terms of globalisation, innovation and development (Chell, 2001). Since many SMIs will be similar to SMEs in peripheral locations it will be difficult for them to produce innovations and competitive products and services in the global market place (McAdam et al, 2004). Alternatively, SMIs like SMEs will have an inherent advantage over larger enterprises when incorporating innovations (Raymond et al, 1998). This is evidenced by the multimedia KM systems being based upon a modular structure which is appropriate to the needs of SMIs. Here museum networks involving SMIs will provide innovatory potential in terms of globalisation and competitive advantage (Chell, 2001).

Likewise the key elements of entrepreneurship will involve innovation, proactivity and risk taking (Miller, 1983). Further to this Zhao (2005) posits that entrepreneurship as organisational behaviour is related to change and innovation and reports that entrepreneurship and innovation are not only closely related but also complementary. Similar to large enterprises larger memory institutions (MIs) will have evidence of "corporate entrepreneurship" or "intrapreneurship". Here Knowledge Management (KM) will have an important role to play and this will have an impact upon SMIs.

Knowledge Management

A KM system for small memory institutions (SMIs) will be the software framework (toolbox) that is intended to assist, through knowledge processing functions, memory institution workers (MIWs). This will enable them to formulate and retrieve knowledge for different museum applications such as collections management, museum collection displays, touch screen displays, virtual museum Web site rooms and museum documentation (reports, information packs, leaflets and books). The various tools of such a framework will help MIWs to originate and organise ideas or understand and communicate information more easily and accurately than can be done with most current tools. The KM system will be an integrated multifunctional system that can support all the main knowledge management processing activities. Current museum knowledge management systems, in particular those in the field of collections management, are too narrow in many respects. A major element of the KM system will be to search for specialised collections information. This will be achieved through an information retrieval component.

Knowledge Management Trends

A wide range of cultural heritage technologies has saturated the European market, especially in the UK. In Italy on the other hand, although there is the presence of considerable resources these technologies have not been as pervasive. In the USA, Canada and Australia, there are many developers of technological solutions in the museums sector. There are therefore opportunities arising from advancing technology, the growth of the Internet and the growing significance of cultural tourism. In these terms museums and their networks have considerable opportunities to develop as tourist attractions. This is especially the case with virtual museums, which can capture visitors to real destinations.

In Europe there are a growing number of small museums developing alongside the large established national museums. Although these enterprises lack financial and technological resources they have freedom, flexibility, dynamism and responsiveness to innovate and induce change. But they lack manpower and quite often knowledge. Also, the financial factor is quite important; small museums usually do not have many resources. Since there is a lack of low cost integrated software solutions for the management of museum data there is a potential market for museum software, which has not been considered.

This chapter illustrates that the successful diffusion of multimedia KM systems into global museum markets involves considerably more than technical competence. Many complementary factors will be prominent. The rapid diffusion of multimedia KM systems will be facilitated by a willingness of SMIs to make adjustments.

Multimedia Knowledge Management Systems

A multimedia KM system is an innovative solution for memory institutions; a technology using highly integrated technologies, organised as a flexible modular system. Such a system can be adapted to any physical context and can be configured with a free number of modules depending on the local requirements and on the available budget. Based on open standards, its architecture can be easily upgraded to integrate innovations in communication, building automation, security in distributed multimedia systems, virtual reality, etc. This policy is in line with the needs of smaller museums that usually cannot afford the investments required. Due to modularity and easy updating: the investments are preserved and enhanced by incrementally adding modules, as new resources become available.

The technological basis enables communication between museums using Intranet and Internet technology. An access system can be available for the visitors both inside the museum and outside, through didactic access points in schools or tourism access points (tourism agencies, airports, road information centres, etc.). Through a collections management core, the whole cycle of generation and handling of multimedia materials (photographs, films, sounds, MIDI music, interviews, clip arts, etc.) can be supported and requires no special competence in information and communications technologies. It features a flexible search engine and accepts most standard digital interchange formats.

Extensions can also be made enabling the implementation of networked museum clusters, in order to leverage the relationship between culture, tourism, and development resources. In fact, evolution will enable:

- Shared museum services, accessible through the Internet.
- Service points such as didactic, ethnographic and editorial laboratories, digital photographic archives, catalogue centres, etc.

Virtual representations which are provided are not meant to substitute actual visits to museums, but aim at valorising the exhibits in their relationship with the surrounding territory. Of course, the system comprehends interesting digital visualisations (3D reconstruction and virtual reality) but the final goal is to improve the visibility and attractiveness of the physical museum.

System architecture can be described as modular and client/server. The whole system can be composed of several components. Only a few of them, which form the core of the system, are always necessary, while all the others are optional and can be combined as needed. Modularity provides advantages in terms of system flexibility, expandability and even fault tolerance. A good independence between components allows the user to easily update, add or substitute them as necessary. Modularity also translates into application fragmentation, that matches the physiology of user access inside museums, where users need to be supported by PC applications several times as they move through the rooms, for a few minutes each time, from many delocalised access points.

For the diffusion of multimedia KM systems it is clear that attention should be paid to SMIs' collections and their heterogeneity. Here there is a need to contain and meet all the requirements of SMIs and their collections need to be considered. The main collection of an SMI will consist of objects whether man made objects or specimens of natural origin. There will also be other types of collections of a supporting nature. These will include libraries and documentation centres and photo archives. The general structure of a multimedia KM system for a small museum can involve the following modules for the full system:

Module	Description
Objects	This is the main module, which enables the SMI to catalogue its collection of objects and specimens.
Documentation	This is a module supporting the museum's library and documentation centre.
Institution	Information of a general nature is provided about the institution.
Events and resources	Information is contained about exhibitions and other events organised by the SMI.
Museum shop	This enables the recording of information about objects from the museum shop.
Narrations	Users are able to create stories providing a context to parts of the SMI's collection.
Procedures	Enables museums to monitor and document collections.
Persons and institutions	This enables SMIs to record information about personnel and SMIs that are linked to the collections or the museum itself
Media	Contains administrative and technical information about images and other media.

Table 6.4: The general structure of a multimedia KM system for a small museum

It is clear that modules will not play the same role in every system. The Procedures module will only be available in a system for a large museum. The Persons and institutions module will also be available in all systems, but only in a very basic version in the Content production and presentation system. The Objects module will play a completely different role in the Content production and presentation system as in the Cataloguing and Collection management systems.

Global Marketability

There will be a combination of forces at interplay, which will determine whether a multimedia system innovation results in global market success. In relation to this there will be the need to:

- Reduce at early stages of development the uncertainty present in the selection process of modules.
- Permit the screening of modules without incurring trial and error strategies of global market introduction.
- Assert a ranking of the available modules, identifying priorities according to global marketability for different small memory institutions (SMIs).
- Perform a requirement analysis for the different types of SMIs using this ranking to favour only those modules, which are appropriate.

This methodology will become "concrete" through global marketability evaluation developed that constitutes a tool able to efficiently assure the attainment of global marketing of the multimedia system innovation involving a low-cost and time-saving module identification process for the different types of SMIs.

Taking the different types of memory institutions, being small (SMI), medium-sized (MMI) and large (LMI), their possible requirements for the different modules are shown below (Table 6.5).

Module	SMIs	MMIs	LMIs
Objects	✓	✓	✓
Documentation			✓
Institution	✓	✓	✓
Events and resources	✓	✓	✓
Museum shop		✓	✓
Narrations	✓	✓	✓
Procedures			✓
Persons and institutions	✓	✓	✓
Media		✓	✓

Table 6.5: Requirement Matrix for the different types of Memory Institutions

This shows that essential modules required by SMIs include objects, institution, events and resources, narrations, persons and institutions. Those modules most likely to be needed by MMIs are objects, institution, events and resources, museum shop, narrations, persons and institutions and media. Due to the larger scale of LMIs they will probably require all the modules. These requirements will be important to the global diffusion of multimedia KM systems.

Museum Networks

Museum networks will be of particular importance to SMIs with little in-house resources and experience to explore the potential of multimedia KM systems. SMIs may lack awareness to the value of the multimedia technology and will therefore rely on co-operation with others. Two basic mechanisms available to SMIs are technology exchange (technology passed from one SMI to another) and technology exploitation (technology transferred to an SMI from an external source).

Museum networks will enable SMIs to reach a common understanding regarding multimedia technologies more quickly. Important aspects of museum networks are the type and size of the network. Whereas small networks appear more efficient, since communications are easy and network dynamics controllable, large networks benefit from a greater pool of resources. "Regional" museum networks are the most complex type consisting of multi-tiered structures linking local networks. These are suitable for heterogeneous SMIs.

In order for museum networks to facilitate SMIs to learn from each other, to exchange experiences, and to diffuse multimedia technology the benefits of "good practice" need to be realised through technology transfer skills (determining a SMIs needs through auditing), technological expertise and know-how, service provision, management and organisation (Commission of the European Communities, 1998). Museum networks will be segmented by geographical region. Procedures will most likely become less formal over time. Good relationships between SMIs will form the basis of good practice. Success in the diffusion of multimedia technology within museum networks will result from following "good practice".

The implications for the global marketability of multimedia KM systems into SMIs, and the technology processes involved, necessitates the need to formulate technology transfer related action. This includes raising SMIs' awareness to the potential of multimedia KM systems to help solve problems and the existence of museum networks to provide practical support. Once SMIs comprehend the possible benefits of multimedia KM systems they will need support to realise the benefits. Two further types of action to achieve this are specific support to individual SMIs and technology transfer support to SMIs in general (to foster technological knowledge). For SMIs adopting multimedia KM systems key mechanisms will include information transfer (newsletters and databases), technology transfer (technology audits), skills transfer (training) and specialist support (financial guidance).

Although the variables involved in the diffusion appear to be the most important influences on the diffusion of the multimedia KM systems into SMIs there will also be a multiplicity of influences that accelerate or alleviate the rate of diffusion. This spectrum of influences broadens when considering technology transfer among the various different types of SMIs. SMIs' sociological forces will have an important role to play. The rate of adoption of multimedia technology will be faster if it is compatible with previous experience and software use and the present normative values of SMIs. Other influences on the speed of diffusion include the complexity of the multimedia technology and random influences.

The successful diffusion of multimedia technology involves considerably more than technical competence. Many complementary factors will be prominent. The rapid diffusion of multimedia technology will be facilitated by a willingness of SMIs to make adjustments.

Conclusions

From the above discussion a number of points arise in relation to the diffusion of multimedia KM systems into global museum markets. These include the groups to be targeted such as museum networks and the involvement of "best practice" activities to enable this process. There will be the need to take into account the overview of the cartography of the target groups. This will involve the determination of which dissemination tools to adapt for the target markets in different countries. From requirements analyses it will be possible to elaborate external dissemination plans. As well as SMIs and policy makers other target groups include public authorities, regional museum authorities, museum networks and clusters. From work undertaken into global marketability it will be possible to identify museum networks and clusters to target. This can be based upon requirement analyses to project the requirements of the different categories of museums. These include local history and culture museums, art museums, castle museums, natural history museums, history and archaeology museums, specialised cultural history museums, science and technology museums, maritime museums, museum/art galleries, industrial and military museums. A general requirement matrix can be constructed for these different types of museums showing their module requirements for multimedia software. By doing this it is possible to 'configure' the requirements of museums for the external global marketing process for the different types of museums. In a study undertaken in 2004 (Thomas and Brooksbank, 2004) marketability lists were assembled for museums in a number of countries including Wales (88 museums), England (187 museums), Italy (500 museums), Spain (147 museums) and Holland (155 museums) according to type, location and region. By sorting on type, location and region it is possible to identify the most important categories of museums and from location and region the local authorities and networks to target.

It is clear that multimedia KM systems for small museums can be marketed widely at a European level but they also have considerable global marketing potential as evidenced in this chapter. Since the global marketing concept of a multimedia museum KM system can aim to maximise the commercial results of the technology an appropriate approach should therefore be used to deal with the effects and reactions of museums to supply and demand. Hence, the commercial aspects in terms of revenues will play an important role in the decisions made by public authorities and private investors in regard to multimedia technology. Thus, such an approach can provide opportunities for improved profit in the form of global market activities. The global marketing aspects will include small museums, especially with regard to their role as sources of revenue. A specific issue for small museums is the need to apply for subsidies and other support for the adoption of multimedia technology. Based upon the perceived values of public authorities and private investors their decision-makers will be prepared to have preference for innovative museum KM systems. The preference will also include factors like local jobs and local income formation, and the socio-political aspects of transparency and direct democratic control.

Further reading

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7 Conclusions

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> *"Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or a different service."*
>
> PETER DRUCKER (1909–2005)

Introduction

Policy cannot force a small business to innovate but it can provide support through networks. When small firms are reached there is a need for policy to have a positive effect on the firm's ability to innovate. Good, well tailored, policy can be effective. To create an environment for small businesses to think in an innovative way is strategically difficult, but operationally possible. Policy can benefit small businesses in areas where they can take advantage of it. The policy needs to be clear regarding what it is trying to target and achieve especially with regard to the processes of invention, innovation, research and development (R&D).

Agri Food – Innovative and Sustainable Solutions

With regard to Agri-food there is considerable scope for the sustainable development of local Agri-food small businesses, to improve quality and lower costs, by adopting "best practice". Knowledge transfer, training, information and advisory services if brought together in a coherent framework will lead to the improvement of the farming environment. At the local community level there are clear benefits for the use of branding by Agri-food small businesses to publicise local foods not only to local people but also to people of local origin or with strong sympathies towards local food products. This can be achieved through vehicles like community projects and the Internet.

The focus on examining "best practice", where there is benefit to Agri-food small businesses, can result in effective "bench marking" of significance to the farming environment. Bench marking can be undertaken for Agri-food small businesses innovative practice against the best in the "class" and by doing this they can improve their competitive positions through awareness and the greater use of bench marking techniques.

Research and Development in Health and Energy small businesses

A major policy question concerning R&D is the extent to which indigenous technology progress is created by local R&D or by developments globally (Revesz and Boldeman, 2006). Needless to say the economic impact of R&D on an economy will be of considerable importance. Within an economy there will be a number of methods used by small businesses to protect the competitive advantage of their new or improved processes and products. A major influence on the commitment to R&D programmes identified in the study of small businesses in the energy and health sectors is to develop intellectual property (IP). Small businesses in markets will often need patents in order to release new products (Mazzoleni and Nelson, 1998) and this is evidenced through patents being taken out by a small percentage of companies.

There is an argument that a nation will receive most of its technology innovations from other countries and with competitive conditions indigenous small businesses will have the incentive to adopt exogenous new technologies without government support. Indeed, at a qualitative level there will be the case both pro and ante for R&D government support and quantitative analysis is required to determine R&D subsidies at an optimum level (Revesz and Boldeman, 2006). A number of surveys in the literature have considered time delay and it is found that time constraints are identified by both energy and health companies as an issue that limits R&D.

Construction – Innovation, Technology and Small Construction Enterprises

With regard to small construction enterprises the literature indicates that utilisation of innovations in new products, services and processes is inherently uncertain and thus dealing with risk and uncertainty is central to innovation management. Encouraging take-up through education and training will therefore involve all parties being provided with knowledge about the innovation itself, and to be inspired and convinced of the possibilities for success (Goffin and Mitchell, 2005). The management of innovation in small construction enterprises thus requires a distinct mix of skills, which will require training. Sharing good training practices to raise skills will ensure that more contractors can secure a share of major projects (ConstructionSkills, 2005).

Museums and Small Memory Institutions – Multimedia Knowledge Management Systems

Finally, in the museum sector multimedia Knowledge Management (KM) systems for small museums can be marketed widely at a European level but they also have considerable global marketing potential. Since the global marketing concept of a multimedia museum KM system can aim to maximise the commercial results of the technology an appropriate approach should therefore be used to deal with the effects and reactions of museums to supply and demand. The commercial aspects in terms of revenues will play an important role in the decisions made by public authorities and private investors with regard to multimedia technology. Such an approach can provide opportunities for improved profit in the form of global market activities. The global marketing aspects will include small museums, especially with regard to their role as sources of revenue. An issue for small museums is the need to apply for subsidies and other support for the adoption of multimedia technology.

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9 About the Contributors

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Lyndon Murphy originates from Ystrad, in the Rhondda Valley, South Wales. He was educated at Tonypandy Grammar School and the University College of Wales Aberystwyth. He is currently an Academic Leader at Newport Business School. In collaboration with Jo Jones and Huw Swayne, Lyndon has published several journal articles and conference papers in ebusiness. Further, he has worked with the Welsh Assembly Government to develop case studies exploring the impact of broadband accessibility on Welsh business performance. Lyndon's current research interests focus upon innovation policy in Wales. This research evaluates both business and social innovation policy outcomes.

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Said Al-Hasan is a Senior Lecturer in Marketing at the Glamorgan Business School, University of Glamorgan. His main teaching areas are Strategic International Marketing, Strategic Marketing Management, Marketing Analysis and Decision Making, Marketing Systems and Structures and Global Logistics. He has an MBA and a PhD, concerning Agricultural Co-operatives and Farmer Controlled Enterprises in Wales, from the University of Wales Aberystwyth, and is a Member of the Chartered Institute of Marketing and Academy of Marketing. His main areas of research involve Benchmarking, Customer Services, Relationship Marketing, Retailing and the Food Industry and Total Quality Management, and he has presented papers at international conferences and published articles in refereed journals.

Gary Packham is Professor and Director for Enterprise for the University of Glamorgan and Head of Programmes for the Glamorgan Business School. He recently managed the prestigious Federation of Small Business' Lifting the Barriers Survey and acts as the Institute for Small Business and Entrepreneurship's regional champion for Wales. Previously, Professor Packham was Head of Division for Enterprise and Economic Development and was academic delivery manager for the circa £14 million ESF project – e-College Wales. He has published widely in the areas of enterprise and small business management and has extensive experience of developing and delivering enterprise and management education. Professor Packham is a Member of the Chartered Management Institute, the Institute for Leadership and Management and a Fellow of the Higher Education Academy. He is also a director of Age Concern Morgannwg Ltd.

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Lisa Powell works in the area of visitor services in Wales and is also involved in teaching in the FE sector in Wales. She has researched regeneration schemes in the South Wales Valleys as a stimulus for innovative heritage enterprise development and this work has been published in an international journal.

Simon Thomas is Senior Lecturer in Tourism and Events and Programme Leader for Sport and Events at the University of Glamorgan Business School. Prior to commencing a career in academia he worked for ten years in visitor services for the Welsh Assembly Government Agency Cadw. His research interests are in heritage representation, identity and interpretation. Present research focus is on the construction of meaning at hybrid touristic pilgrimage sites in Western Europe concentrating on Lourdes in south west France. Recent consultancy projects include the supervision of a Knowledge Transfer Partnership at The Cardiff Story Museum, an innovative publicly funded museum telling the rich and varied story of Cadiff. Simon is currently working towards a Doctorate in Business Administration at the Glamorgan Business School.

Robbie Williams is a researcher based at NEO. Previous assignments include working on the Welsh element of the Global Entrepreneurship Monitor (GEM) project, which is recognized as the world's largest international study of entrepreneurial activity. His research interests are in small rural firm's entrepreneurship, capability and interaction with government rural development policy, and he has a Doctorate in this area from the University of Glamorgan. Present research focus is on the role and impact of Social Enterprise in deprived areas of Wales. His work on topics relating to small rural business, social enterprise activity and enterprise education has been published at a number of international and national conferences.

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