# Cluster Building By Policy Design:

## A Sociotechnical Constituency study of Information Communication Technology (ICT) Industries in Scotland and Hong Kong

**Volume I**

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## Statement of Original Authorship

I hereby declare that this thesis has been composed by myself, the work is my own and it has not been submitted for any other degree or professional qualification, except as specified on the title page

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# Abstract

This thesis investigates whether and how public policies can help build industrial clusters. The research applies a case study method based on 60 interviews to the emerging information communication technology (ICT) clusters in Scotland and Hong Kong. The analysis uses Molina's sociotechnical constituency (STC) framework and its associated 'diamond of alignment', which help focus on two interrelated dimensions: 1) the complex technical and social aspects of the design, implementation and evolution of the Scottish and Hong Kong ICT clusters and 2) the difficulties of developing a cluster in the context of major diversity of organisational interests and patterns of interaction. This research revealed that the cluster building effort in the two regions has been fraught with difficulties due to misalignment between the perceptions and pursuits of policy makers and the interests of industry members. This thesis concludes that cluster building is an evolutionary process of sociotechnical alignment which can be facilitated by feedback and learning. It also suggests that for successful cluster building to take place, policy makers should focus on stimulating the processes of cluster formation, including the building up of the technological capabilities of the industrial actors, while facilitating the integration of the major actors' interests and demands with the policy programmes. Cluster building involves the development of new ways of thinking as well as the practice of networking; it necessitates the coherent effort of collective learning and a long-term commitment to change the existing technological system. A long-term adaptive policy programme should be pursued to focus on effectively aligning the interests and pursuits of the different actors in the cluster at various stages.

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## Abbreviations

| | |
|---|---|
| ACa | Alba Campus |
| AIM | Alternative Investment Market |
| AMPS | Admission of Mainland Professional Scheme |
| AMT | Advanced manufacturing technology |
| AR&DF | Applied R&D Fund |
| ARF | Applied Research Fund |
| ASIC | Application specific integrated circuit |
| ASTRI | Applied Science and Technology Research Institute |
| ATS | Admission of Talents Scheme |
| BERD | Business expenditure on R&D |
| BGF | Business Growth Fund |
| CAD | Computer-aided design |
| CAIT | Council of Advisors on Innovation and Technology |
| CAM | Computer aided manufacturing |
| CAR&DF | Cooperative Applied R&D Fund |
| CEPA | Closer Economic Partnership Arrangement |
| CIF | Co-Investment Fund |
| CP | Cyberport |
| DA | Development area |
| DMC | Digital Media Centre |
| DSI | Design Smart Initiative |
| DTI | Department of Trade and Industry |
| EDA | Electronic Design Automation |
| EF | Scottish Enterprise/Royal Society of Edinburgh Enterprise Fellowship |
| ES | Electronics Scotland |
| FEDS | Framework for Economic Development in Scotland |
| FPGA | Field programmable gate arrays |
| FTS | Fresh Talent Scheme |
| GDP | Gross domestic product |
| GEM | Global Entrepreneurship Monitor |
| GEMt | Growth Enterprise Market |
| GERD | Gross domestic expenditure on R&D |
| GGS | Gyro Gun Sight |
| G-HKTCFS | Guangdong and Hong Kong Technology Cooperation Funding Scheme |
| GSP | General Support Programme |
| GVA | Gross value added |
| HEI | Higher education institution |
| HKDC | Hong Kong Design Centre |
| HKITCC | Hong Kong Industrial Technology Centre Corporation |
| HKJCICM | Hong Kong Jockey Club Institute of Chinese Medicine |
| HKPC | Hong Kong Productivity Council |
| HKSE | Hong Kong Stock Exchange |
| HKSP | Hong Kong Science Park |
| HKSTPC | Hong Kong Science and Technology Park Corporation |
| HKVCA | Hong Kong Venture Capital Association |
| HV-SoC | High voltage system-on-chip |
| IC | Industrial cluster |

| | |
|---|---|
| ICASS | Innovator's Counselling and Advisory Services for Scotland |
| ICDC | IC Development Centre |
| ICs | Integrated Circuits |
| ICT | Information communication technologies |
| IF | Industrial Fellowships |
| IHK | Invest Hong Kong |
| InnoC | InnoCentre |
| IP | Intellectual properties |
| IRCS | Industrial Research Chair Scheme |
| ISF | Industrial Support Fund |
| ISLI | Institute of System Level Integration |
| ITC | Innovation and Technology Commission |
| ITDC | Industry and Technology Development Council |
| ITF | Innovation Technology Fund |
| ITI | Intermediary Technology Institute |
| ITSP | Innovation and Technology Support Fund |
| JEMI | Joint Equipment and Materials Initiative |
| LCDs | Liquid crystal displays |
| LEC | Local Enterprise Companies |
| LED | Light emitting diode |
| LINC | Local Investment Networking Companies |
| LIS | Locate in Scotland |
| MCC | Microelectronic and Computer Technology Corporation |
| MGJR | Matching Grant for Joint Research |
| M-HKJRF | Mainland-Hong Kong Joint Research Fund |
| M-HKSTCC | Mainland and Hong Kong Science and Technology Cooperation Committee |
| MNC | Multinational corporations |
| MPU | Microcontroller |
| MTC | Microelectronic Test Centre |
| NMI | National Microelectronics Institute |
| NSI | National system of innovation |
| NTTS | New Technology Training Scheme |
| OBM | Original brand name manufacturing |
| ODM | Original design manufacturing |
| OECD | Organisation for Economic Cooperation and Development |
| OEM | Original equipment manufacturing |
| PAG | Patent Application Grant |
| PC | Photonic Centre |
| PCBs | Printed circuit boards |
| PCF | Proof of Concept Fund |
| PDAs | Personal data assistants |
| PRD | Pearl River Delta |
| R&D | Research and development |
| R&DC | R&D Centres |
| RMB | Renminbi |
| RSA | Regional Selective Assistance |
| RSE | Royal Society of Edinburgh |
| RSI | Regional system of innovation |
| SAR | Special Administrative Region |

| | |
|---|---|
| SARS | Severe Acute Respiratory Syndrome |
| SCF | Scottish Co-investment Fund |
| SCIS | Small Company Innovation Scheme |
| SDA | Scottish Development Agency |
| SDAa | Special Development area |
| SE | Scottish Enterprise |
| SERAP | Small Enterprise Research Assistance Programme |
| SEED | Scottish Executive Education Department |
| SEEL | Scottish Enterprise Edinburgh and Lothian |
| SEELLD | Scottish Executive Enterprise and Lifelong Learning Department |
| SEF | Scottish Electronic Forum |
| SESC | Scottish Embedded Software Centre |
| SHEFC | Scottish Higher Education Funding Council |
| SIE | Scottish Institute for Enterprise |
| SIS | Sectoral innovation systems |
| SMC | Scottish Microelectronic Centre |
| SME | Small and medium sized enterprise |
| SMEC | Small and Medium Enterprise Committee |
| SMEF | Small and medium sized enterprise Fund |
| SOA | Scottish Optoelectronics Association |
| SOC | System on chip |
| SSA | Scottish Software Association |
| SSF | Service Support Fund |
| SSSF | Scottish Semiconductor Supplier Forum |
| STC | Sociotechnical constituency |
| STI | Science and technology input |
| TC | Technology Centre |
| TCS | Teaching Company Scheme |
| TDC | Trade Development Council |
| TS | Technological system |
| TSMC | Taiwan Semiconductor Manufacturing Company |
| TVS | Technology Venture Scotland |
| UICP | University-Industry Collaboration Programme |
| UMC | United Microelectronics Corporation |
| UNESCO | United Nationals Educational Scientific and Cultural Organisation |
| VC | Venture capital |
| VCX | Virtual Component Exchange |
| VLSI | Very large scale integration technology |
| WCL | Wireless Communications Laboratory |
| WDC | Wireless Development Centre |
| WHO | World Health Organisation |

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# Chapter 1 Introduction

**Objective: to provide an overview of the research problem, methodology and justification for this research**



## 1. Introduction

A cluster is a group of inter-related companies and institutions of a specific industrial sector which network with each other to improve their overall competitiveness. They can be made up of each other's customers, suppliers, researchers, financiers, partners or competitors. Examples of prominent clusters are the financial services in London, the fashion industry in Paris, the information technology industry in Silicon Valley of California and the car-making industry in Stuttgart, to name but a few. A number of scholars and policy makers believe that as the companies and organisations in a cluster invest in a specialised but related area, they can share the infrastructure, information and human resources available. Also, the combined forces of cooperation and competition within the cluster can lead to an improvement in productivity, an increase in business birth rate and the generation of innovation and inward investment. In other words, a strong and sustainable cluster can help develop the competitive advantage of a country or region.

In the knowledge-based economy, innovation and technology have been recognised as the keys to enhance the productivity and competitiveness of a nation. The success of clusters like Silicon Valley in California and Route 128 in Boston, USA, has inspired many governments of the world to apply the cluster model as their economic development strategy, especially to boost the development of the high technology industries in their countries. As a consequence, a large number of planned clusters have appeared all around the world under the names of ‘technology park’, ‘science park’, ‘technopolis’, ‘science city’ and ‘supercorridor’, etc. Despite the potential benefits to a nation of having a successful cluster, creating one is not an easy process. In fact, many attempts at creating clusters in the world have failed, despite the investment of enormous effort and resources. Without a clear understanding of what clusters are and what processes are involved in creating a cluster, it is less likely that a cluster can be built successfully. Therefore, the objective of this thesis is to outline and explain the nature, challenges, and difficulties of building a sustainable cluster.

This study only covers the geographically concentrated industrial clusters. Although the development of information communication technology (ICT) has facilitated the emergence of so-called ‘virtual cluster’, which is less geographically related, many studies show that geography is still an important dimension in the economy of the modern world. (That is why, for example, MNCs locate their operations in some countries, and not in others). This study has chosen two emerging ICT clusters—those of Scotland and Hong Kong respectively—to shed light on the process of building a high technology cluster. These two regions have been important manufacturing bases for the electronics industry for more than 30 years. Since the last decade, the governments of the two regions have started to create knowledge-based ICT clusters based on their successful electronics industries. The Scottish government launched its ‘Alba Project’ in 1997, targeting the development of a cluster of high value added microelectronics and information technology industries to boost the region’s economy. The Special Administrative Region (SAR) Government of Hong Kong also announced the creation of its first science park in 1999, namely the ‘Hong Kong Science and Technology Park’. The aim is to transform Hong Kong into an innovation hub for Asia by developing a cluster of strong electronics and information technology industries.

This thesis seeks to improve our understanding of the nature of clusters and of the processes involved in cluster building, and to identify the obstacles that affect the development of clusters through a comparative analysis of these two case studies. The ultimate goal of this thesis is to contribute to the theory and practice of cluster strategy and will concentrate, in particular, on the processes involved in building a cluster. It is expected that the insights from this thesis will make a contribution to policy makers’ design and practice of policy programmes that aim to create sustainable clusters, and can thus enhance the competitive advantages of their nations.

Previous work on clusters has hardly addressed the theoretical and research issues involved in a systematic understanding of the complex set of processes, factors and issues involved in cluster creation by policy design. This 'processual' understanding of a large social, cultural, political and economic phenomenon such as clusters demands a research approach that integrates at least the following elements:

- Critical review of multiple theoretical perspectives related to the processual understanding of clusters. This includes theories of regional development, technological innovation, alliances, collaborations and networks, national systems of innovation, regional systems of innovation, industrial clusters, and technological and socio-technical systems
- Longitudinal analysis over a sufficiently extensive period of time. In this work this period extends for about 10 years.
- Multi-level approach that integrates the analysis of the processes of cluster-building ('meso' cluster level), on the one hand, to their regional industrial contexts ( 'macro' regional industrial level) and, on the other, to their component processes ('micro' project level). In this work, the regional industrial context also provides an idea of the initial conditions of the cluster-building process; while the 'micro' project level concentrate on the 'flagship' projects of the cluster building processes.
- Comparative analysis of at least two clusters to enable an understanding of particularities and similarities of different cluster processes and to test the validity of the analytical approach used.

The research conducted for this thesis has sought to implement all these elements in a thorough manner. This resulted in an extensive amount of written material that surpassed the limits imposed by today's university procedures regarding length of Ph.D dissertations. This is reflected in the structure of the thesis that has had to make choices in the way the argument is presented to allow for both respect of the recommended limit and the presentation of the full version of the work done. In a sense, this means that the reader will find two versions of the thesis in the single piece of submitted work. The shorter version consists of the chapters in the main body of the thesis, while the longer version also includes the analytical material in the various Appendices. Thus, the shorter version of the thesis presents an abridged version of the review of literature concentrating on the theoretical approaches most directly related to the theoretical framework chosen by the author to deal with the 'processual' analysis of cluster building by policy design. The remaining review of literature is presented in Appendix 1 and 2 and is part of the long version of the thesis. Likewise, the discussion on Methodology is summarised in chapter 3 of the short version of the thesis, while the extensive discussion is found in Appendix 3 (part of the long version of the thesis). Finally, the short version of the thesis concentrates on the comparative analysis of the 'meso' cluster level for the cases of Scotland and Hong Kong, while the Appendices 4 and 6 contain the analysis of the 'macro' regional industrial levels in these two countries. In addition, Appendix 5 contains the analysis of the 'micro' project level for the case of Scotland (i.e., flagship project Alba). The 'micro' project level analysis for the case of Hong Kong is not included in the thesis, although the research is available. This structure allows for the presentation of the full analysis integrating all the elements identified above, while respecting university norms through a shorter version that maintains the originality of the rigorous comparative 'processual' analysis of clusters in two countries.

## 1.1 Theoretical Background

*This thesis has conducted an extensive review of theoretical literature found in Chapter 2 and Appendix 1 and 2. The following provides a brief introduction.*

Economists have long regarded innovation as an essential condition of economic growth and national competitiveness. In his book *The Wealth of Nations,* Smith (1925) [1776] describes how improvements in machinery and the division of labour have led to specialised inventions. Marx (1976) [1867] gives a central role to technological innovation of capital goods in his model of a capitalist economy. Marshall (1890) also reaches a conclusion that 'knowledge' is the chief engine of economic progress.

However, economists stopped studying technological change and only in recent decades has this changed. According to Freeman and Soete (2000), this is due to the fact that neo-classical economists usually exclude technological change from consideration under the traditional assumption of *ceteris paribus* (all things being equal). They tend to treat technological change as an 'exogenous variable' in the study of economic progress.

Schumpeter (1934) is one of the first economists to conduct a systemic analysis of technological change and innovation. He regards innovation as a major source of entrepreneurial profit and a key driving force of the capitalist system. Building on his studies, neo-Schumpeterian economists such as Nelson and Winter (1974) propose an evolutionary economic theory and argue that innovation is a knowledge-seeking activity that is carried out by firms in response to the environment conditions.

Over the last two decades, the relationship between innovation and economic growth has caught the central attention of a number of scholars. Porter (1990) argues that innovation activities will be enhanced in a 'cluster' environment with firms and supporting institutions of the same field agglomerating in a particular location. His study has led to a wave of research devoted to models and analysis of clusters. Clusters can be defined either by geography, such as a nation or region, or by industrial sector or specific technology. The geographical perspective focuses on the importance of the geographical agglomeration and its proximity to innovation. Examples of such works include flexible specialisation (Piore and Sabel, 1984), industrial system (Saxenian, 1994), regional worlds (Storper, 1994), national system of innovation (Lundvall, 1992; Nelson, 1993) regional innovation system (Cooke et al., 1997; Braczyk et al., 1998), and technopoles (Castells and Hall, 1994).

While the geographical perspective mainly outlines the cluster of industrial activities in a specific nation or region, the technological and sectoral perspective is more technologically or industrially focused. It emphasises the characteristics of specific technology fields and the networking taking place among different organisations, with or without reference to geographic agglomeration. Major works on this include industrial cluster (Porter, 1990), technological system (Carlsson and Stankiewicz, 2000), sectoral innovation system (Breschi and Malerba, 2000) and sociotechnical constituency. (Molina, 1993, 1999; Kinder and Molina, 1999)

Although both the geographical and technological perspectives suggest that clustering of firms and supporting institutions will have positive impact on economic and technological development and innovation, the two perspectives still leave a number of puzzles remaining unsolved: What kind of processes are involved in a cluster? Can we create a cluster through purposive policy-making? What are the factors that influence a cluster's success and failure? Central to a cluster is the networking and the flow of commercial, technological and social knowledge among the firms and institutions. Three bodies of literature on network analysis have been consulted in this thesis. They are the management literature, the innovation studies literature and science and technology studies literature.

*Management Literature*

The management literature on network analysis mainly focuses on different rationales of firms entering into networks. Research on the subject can be broadly divided into three main perspectives, namely the economic, knowledge, and social perspectives. For the economic perspective, the market power theory (Porter, 1980; Preece, 1999) draws attention to power relationship and its implication for a firm's positioning strategy. The transaction costs theory (Williamson, 1979) highlights the importance of flexibility and control in striking a balance between 'market' and 'hierarchical' organisational form. Within the knowledge perspective, the resources competence theory (Penrose, 1959) emphasises the significance of unique resources in sustaining competitive advantage and regards networking as a process of purposive organisational learning, through which a firm can internalise the resources needed to improve its performance. (Child and Faulkner, 1998) Finally, the social perspective suggests that social relations based on trust are important to a network. (Casson, 1995) The business ecosystem theory views the sustainability of the network depending on the centre firm's ability to maintain the governance of the network. (Lorenzoni and Baden-Fuller, 1999)

*Innovation Studies Literature*

Research on networks by innovation studies is mainly concerned with the nature of technological networks and the factors contributing to technological collaboration among innovating firms. Project SAPPHO highlights the importance of external networks to successful innovation. (Freeman, 1991) The existence of technological uncertainties can be viewed as the prime driver of firms entering into networks. (DeBresson and Amesse, 1991) Teece (1986) explains that technological collaboration among firms is conditioned by three factors: appropriability regime, complementary assets and dominant paradigm. Arora and Gambardella (1990)'s research on the biotechnology industry confirms that technological collaboration between firms is a useful way to access complementary assets, including physical resources and knowledge base. Apart from inter-firm networks, in-house R&D is usually complemented with links with university, government laboratory and research association. (Rosenberg, 1992; Faulkner and Senker, 1994, 1995) The empirical studies on technological collaboration also demonstrate the importance of both formal and informal networks (Macdonald, 1992; Smith et al., 1991) and that the maximum gains from collaboration build on mutual trust and reciprocity. (Aoki, 1986; Smith et al., 1991)

*Science and Technology Studies Literature*

Another approach for studying networks comes from science and technology studies. Originated from sociology, three themes in the literature are worthy of notice. First, science and technology studies emphasise the interactive relationship between society and technology in technological change. Hughes (1983) proposes to use a 'system' or 'network' approach to study this relationship. Heterogeneous professionals and organisations interact in a technical system as if they are in a seamless web. Second, science and technology studies highlight the importance of different 'actors' in technological development. Actors are referred as 'relevant social groups' in the social construction theory (Pinch and Bijker, 1984), who generate 'interpretative flexibility' as the same technology means differently to different social groups. Actor network theory (Callon, 1986) attempts to further break down the distinction between human and non-human actors, both are treated as elements in the 'actor network'. Callon points out that actors must have their attributes being defined or translated, so that their roles in the network can be conceived by other actors. Finally, science and technology studies demonstrate the 'problematic' nature of technological change. The actor network approach stresses that there is always some degree of divergence between the elements of a network. Law (1987) coins the tactic of system building as 'heterogeneous engineering' which means putting a range of disparate elements into a network of juxtaposed components. Molina (1990)'s sociotechnical constituency approach also highlights the nature of mis-alignment in the process of constituency building, and that constituency builders have to seek compromise and accommodation continuously to re-establish alignment between the constituent parts. (see Appendix 1 for the full version of the literature review on the background theories of clusters and Appendix 2 for the full version of the literature review on the theories directly relevant to the study of clusters)

Having briefly reviewed some of the literature on clusters, it seems that several areas have been under-researched and require further study.

- Firstly, at present there is little consensus on the common elements of a cluster and the dynamics that underlie technological change and innovation within a cluster.
- Secondly, there are many different approaches to the study of clusters. However, most of them tend to concentrate on factor conditions (such as Porter's industrial cluster) and the institutional set up (such as Lundvall's systems of innovation) that

make up a successful cluster. Apart from Lundvall's reference to learning processes, they provide little understanding on the processes of the formation of a competitive cluster.

- Thirdly, most of the theoretical approaches to the study of clusters are based on extensive empirical research on established clusters, such as those in Europe (for instance, the work by Lundvall, Nelson and Cooke) and the US (such as the work by Saxenian, Piore and Sabel). Such research evidence is more likely to present a retrospective view. On the other hand, emerging clusters under development have not received a similar amount of interest by scholars.

On the whole, it seems that the literature consulted above has left a research gap on the understanding of cluster building processes. It fails to provide answers to questions such as: What kinds of processes are involved in the purposive creation of a cluster? How can these processes be made operational for strategy and policy purposes? What are the most appropriate policy programmes to build a sustainable cluster? Though there is no straightforward answer to these questions, they are important areas that deserve further investigation. As we shall see, a useful conceptual framework for studying the cluster building process comes from the sociotechnical constituency ('STC') approach. (Molina, 1990, 1999, Molina and Kinder, 2001) The strength of this approach is not only in its usefulness in identifying the technical constituents (e.g. technology, process and system) and social constituents (e.g. people and institutions, their goals and perceptions) which interact in a specific circumstance to shape the cluster. It is also in its ability to offer a theoretical framework -the 'diamond of alignment'- for analysing the process of alignment between these technical and social constituents involved in the cluster building process. The STC approach also conceptualises both the inter-organisational and intra-organisational networks into multi-layers of the sociotechnical constituency, and is therefore particularly suitable for analysing complicated multi-level networking activities such as building a cluster.

## 1.2 Research problems

This thesis aims at studying **how an industrial cluster can be built by policy design** and **what processes are involved in cluster building**.

Four main research questions in relation to the cluster building process are formulated with reference to the STC approach.

- **What is the nature of the processes involved in the purposive attempts to create clusters?**
- **How are clusters' visions, strategies and policies created and implemented?**
- **What factors and difficulties influence or affect the translation of cluster visions and strategies when put into practice?**
- **Can a general good practice be identified for policy processes in different regions or countries?**

The first research question attempts to examine the nature of the cluster building process. This area of study is problematic because there is little common consensus on the common characteristics and dynamics of a cluster. Therefore, this thesis starts with an investigation of the general nature and dynamics of a cluster and looks at how this nature is related to its building process. The STC approach is useful for studying the nature of the cluster as it conceptualises the cluster building process into a creation of sociotechnical constituency. As already said, in the STC approach the process of building a cluster is represented by the interaction between technical constituents and social constituents in the STC. An understanding of the nature of the process of cluster building can help policy makers design better cluster policy programmes.

The second question aims to address another important dimension highlighted in the STC approach, which is the vision, goal and commitment of the constituency's leaders in driving the cluster development. As mentioned earlier, most of the existing empirical research on cluster mainly focuses on established clusters and one of their weaknesses is that very few of them explain why people other than policy-makers want a cluster and nor do they explain how a cluster is created in the first place. However, these issues would have major consequences with regard to the development of a cluster in terms of the design of the cluster strategy and the implementation of the cluster policies. Another important insight from the STC approach is that a cluster's success depends upon the extent to which an individual constituent aligns its perceived interests with those of the rest of the constituency, even if this includes competition. It is believed that a cluster would have a better chance of success if an alignment of the visions, interests and pursuits among the major actors in the cluster can be sought and the cluster policies targeted to the most appropriate expertises, resources and areas of concern of the major actors.

The third research question tries to identify the difficulties of creating a cluster. Most of the studies of clusters point to the benefits to a nation of having a cluster. However, not many of them have adequately addressed the difficulties in creating a cluster. In fact, problems are inevitable in the cluster building process and the continuous growth of a cluster relies on the ability of cluster builders to solve the problems that appear at different stage of its development. This seems to be a major factor in explaining why some clusters succeed but others do not. The STC approach highlights when misalignment of constituents takes place, the cluster builder has to establish or re-establish alignment through compromising and accommodating the perceptions, interests and concerns among different constituent parts. In addition, the diamond of sociotechnical alignment is a useful analytical tool for assessing the success and failure of the cluster building process. The diamond of alignment outlines four critical dimensions that must be kept in alignment in order to build a cluster. These four dimensions also represent crucial focal points for cluster builders to manage their alignment strategies and tactics.

The last research question is intended to explore the general best practices for building clusters in different countries or regions. The innovation system approach emphasises that specific national, historical and institutional factors have critical impacts on cluster development. Therefore, the comparison between the Scottish and Hong Kong cases will help reveal the impact of national characteristics on the diversity of approach in the cluster building process and identify the common principles that underlie the success and failure of these cluster building processes. The cross-country comparison also represents an element of triangulation, which overcomes the potential methodological weakness of using a single case study.

In short, the objectives of this research are threefold: first, to advance the existing theory of clusters, especially the cluster building process; second, to undertake an empirical research on the ICT clusters in Scotland and Hong Kong, with the aim of assessing the strengths and weaknesses of these two clusters; and finally, to draw out implications for policy makers and company managers to enhance the cluster building process in these two regions.

## 1.3 Justification of the research

This thesis examines the cluster building process by using the empirical cases of the information communication technology (ICT) clusters in Scotland and Hong Kong. The justifications for this research are outlined below:

### 1.3.1 Importance of ICT industries

This study is limited to the information communication technology (ICT) industries. ICT refers to the computing and telecommunication technologies used for processing, storing, displaying, communicating and managing information in digital forms. The ICT industries covered in this research can be broadly divided into the following six segments:

- Computer & peripherals
- Consumer electronics
- Telecommunications equipment
- Electronic parts and components
- Photographic and optical equipment
- Computer software

The research data of this study is exclusively confined to the ICT industries in the manufacturing sectors of Scotland and Hong Kong, while the provision of information technology services which belong to the service sector is excluded from this study. The decision to focus on the ICT industries is based on the following considerations:

First, ICT is a growing industry with huge potential economic benefits in the longer term. Scotland has developed a strong ICT sector based on its electronics components (semiconductor) industry since the 1950s. Currently, Scotland has the greatest concentration of semiconductor supplier companies in Europe, its production capacity accounting for 7% of Europe and 47% of the UK. Hong Kong's ICT industries also started as early as the 1950s. Until now, ICT industries, especially consumer electronics, remain the second largest manufacturing sector in terms of output (measured in total value of domestic export) and in the number of enterprises in the region. Hong Kong is also the world's second largest exporter of a number of consumer electronics such as radios, telephone sets and calculators in value terms. Owing to the economic significance of ICT industries to the two regions, both governments have chosen the ICT sector as their pioneering target for cluster development.

Second, ICTs are technologies that help induce significant network activities in clusters. ICT companies tend to use more external networks than those in the traditional industries for the following reasons:

1). ICT is knowledge intensive and is subject to substantial industrial research and development (‘R&D’). Despite the enormous potential economic return from successful ICT products, the huge R&D costs of new products, coupled with the rapid pace of technological development are the cause of great uncertainty to ICT companies, as substantial losses are likely to be incurred by those who fail. As a result, companies are increasingly drawn to collaborate in technological development so as to share these costs and reduce the risks.

2). Owing to the emergence of ‘inter-operability standards’, ICT companies are more likely to collaborate and to develop configurational technology—a complex array of standardised and customised automation elements. (Fleck, 1992) Configurational technologies offer a cheaper way to meet the particular needs of an organisation, rather than them having to develop fully customised solutions. Therefore, standard components such as fibre optics, microprocessors and software have to be ‘configurated’ and knit with customised components to match the particular circumstances of use. This necessitates the adoption of a network approach by many ICT companies.

3). ICT technology has not yet fully realised its potential. Today, ICT companies look for opportunities to further exploit the convergence of information, communication and broadcasting technology to multimedia, which enables the storage, processing and transmission of a large volume of digitalised information consisting of text, graphics, sound and video. The expectation regarding the future applications of the converging technologies has profound implications for the industry, as companies embark on collaborations to explore the growing linkages between technologies.

### 1.3.2 To address the research weaknesses of previous study of clusters

This research studies the cluster building processes in Scotland and Hong Kong and addresses important weaknesses of the previous research. The research design of this study has the following features:

Firstly, two emerging clusters have been chosen as in-depth case studies for this research: the ICT clusters in Scotland and Hong Kong. These two cases are chosen for the following reasons:

- The two clusters are emerging and therefore a retrospective view can be avoided.
- The two clusters have been initiated ‘top down’ by the governments in the two regions in contrast to more ‘naturally’ ‘bottom-up’ clusters like Silicon Valley. Therefore, we can look at how governments attempt to create clusters through public policy initiatives.
- The two clusters are in the midst of their development, thus enabling us to examine the real-time development of cluster building processes through government intervention.
- The two emerging clusters are located in the West and the East respectively, reflecting their distinctive European and Asian contexts. This contributes to the understanding of cluster policies across countries with different histories and cultures, thus helping to identify common principles underlying the success and failure of the cluster building processes. It also helps enhance the level of confidence in the results of the research through triangulation of the data gathered from different places.

Secondly, in contrast to many previous researches that focused mainly on the ‘content’ of a cluster (i.e. examining the factor conditions and structural elements), this research investigates a cluster from a holistic perspective, including the ‘context’, ‘content’ and the ‘process’ of the cluster. In terms of ‘context’, data is collected on the economic and industrial backgrounds of the two regions, while their relationship to the origin and development of the clusters is also examined. In terms of ‘content’, in addition to the factor conditions and institutional set up, an understanding is sought of the nature and extent of the networking activities which take place among the major actors of the clusters, including ICT companies, universities and research institutes, government bodies, financial communities and networking organisations. The major barriers to their networking activities are also discussed. Finally, in terms of the ‘process’ this research adopts a longitudinal approach to look at the ten year development of the two clusters including the design, implementation and evolution of the cluster strategies, as well as the specific policy programmes and governance of the clusters in the two regions. It is believed that the research design in this study will provide a deeper picture of the cluster building process.

Thirdly, some major approaches to the study of clusters tend to be descriptive and primarily focused on the technical make up (factor conditions and institutional set up) of the cluster. In contrast, by using the STC approach, this study looks at the wider range of constitutive elements of a cluster, including the technical and social constituents with their perceptions, goals, actions and resources, all of which represent the dynamic social content of the cluster. As indicated earlier, the process of cluster building involves the interaction among these social constituents, who seek to align others to enhance resources and overcome constraints and so shape the technology and social institutions to reach their purposes. This processual dimension helps generate insights into the social and cognitive requirements of the cluster building process.

Fourthly, the investigation of the cluster building process in this research is multi-level, that is, grounded on a detailed analysis at three levels: the contextual regional-industrial level, the cluster level, and the (flagship) project level. Again, as already anticipated, the STC approach conceptualises multi-dimensions of process interaction into different and interrelated layers of social and technical constituents. Indeed, the processes of both cluster building ('meso' level) and project building ('micro' level) can be treated as the build up of sociotechnical constituencies at different interrelated levels. In this set up, the 'cluster-building' process is the immediate context of the 'project-building' process and, conversely, the 'project-building' process is a constituent of the 'cluster-building' process. At the same time, the regional-industrial context ('macro' level) can be treated through the lens of the NSI/IC approaches. This represents the immediate contextual level of the cluster-building process ('meso' level), and includes the economic environment and institutional set up of a regional innovation system, with its industry and technological capabilities. Relevant constituents of the cluster-building process include companies, universities, government bodies, funding bodies and networking organisations, etc. In a sense, all these organisations are also engaged in their own constituency-building processes so that, in general, the bigger constituency of an ICT cluster is constituted by the networking activities among a range of different smaller constituencies and is conditioned by the contextual regional environment.

As such, cluster building is a process of sociotechnical alignment that takes place at the contextual and intra and inter-organisational levels.

### 1.3.3 Usefulness of the potential application of the research findings in Scotland and Hong Kong

As mentioned above, cluster development is one of the important focuses of the economic and industrial policies of Scotland and Hong Kong. Currently, Scotland is moving towards the vision of creating an ICT industry with innovation as its core. Similarly, Hong Kong strives to become a hub for high value added, skill intensive ICT product production and related services in Asia. Therefore, creating a sustainable cluster has become the core of the two governments' strategy to modernise their industrialised economy to a knowledge based one.

Some of the literature, such as those on systems of innovation, shows that government policies have a significant impact on the development of technology and innovation in a nation. In particular, government has a major role in the provision of appropriate institutional set up and in the design and implementation of innovation and technology policies. This research can be useful to the governments in Scotland and Hong Kong in two ways:

- First, it introduces theoretical tools that can be used by policy makers to analyse the cluster building process. Since a number of frameworks for the study of clusters exist, policy makers may be confused about the strengths and weaknesses of each one and their application to empirical cases. This research not only proposes a framework which integrates the complementary insights from different frameworks, but also introduces theoretical tools which can be of use to analyse and assess the success and failure of a cluster, which may help governments to monitor their respective clusters at various stages of development.

- Second, it suggests implications for policy makers to enhance the cluster building process in the two regions. Cluster policies must be designed to best suit the specific circumstances and to meet the needs of the major actors of the cluster. This research is also concerned with the translation of the cluster strategy into actual policy programmes to meet the needs of stakeholders at large. By looking at the problems that Scotland and

Hong Kong face in the process of cluster building, and how the government of the two regions address them, other countries can learn how to avoid the same pitfalls in their own attempts at cluster building. On the whole, the experiences of Scotland and Hong Kong have important implications for other 'latecomer' regions that may want to upgrade their technological and cluster development.

## 1.4 Methodology

### 1.4.1 Overview of the methodology

A retroductive research strategy (Blaikie, 2000) which combines both deductive and inductive approaches has been adopted in this research. For the deductive strategy, the combined insights from different literature, in particular the theories of clusters (Porter, 1990), innovation systems (Lundvall, 1992; Cooke et al., 1997) and sociotechnical constituency (Molina, 1993) are used to form the major framework in this research. Then, an inductive strategy is applied to compare the results of the empirical studies with the theories and literature consulted. The newly found insights can help in two ways: (a) advance our understanding of the cluster building process and (b) produce better-informed advice for policy makers and company managers.

This research chose to apply a qualitative methodology. To answer the four research questions stemming from the research problem: 'How can an industrial cluster be built by policy design?' necessitates an exploration of the cluster building process in a longitudinal perspective. At the same time, it involves dealing with various cognitive and intangible concepts, like visions, perceptions, knowledge, learning, networks, etc. The application of a qualitative methodology enables the researcher to go beyond description to look for deep explanations to complicated phenomena such as cluster building.

To reach a holistic comprehension of the cluster building process, the research design identifies five elements aimed at examining the 'context', 'content' and 'process' of cluster-building as follows:

1. Mapping of the ICT clusters in Scotland and Hong Kong
2. Context analysis of the two clusters, using the cluster/NSI framework
3. Longitudinal study of the two clusters for ten years, using the sociotechnical constituency approach

4. Auditing the success and failure of the two clusters, using the diamond of alignment of the sociotechnical constituency approach at the end of each phase during the ten-year development process
5. Comparing the cluster-building processes in Scotland and Hong Kong and identifying general good practices for cluster building

A case study method based on archive analysis and semi-structured interview is the most suitable to the qualitative and longitudinal methodology applied in this study. Thus, this research starts with a contextual overview of Scotland's and Hong Kong's economic and industrial characteristics and their institutional arrangements for supporting the science and technology development and innovation. Sources of information for the contextual study come mainly from archives, such as government policy documents, census and statistical data, reference books, newspapers, magazines and other on-line information. The contextual study has a threefold purpose: (a) to provide background insights for the empirical part of the research, (b) to enhance our understanding of the historical and socio-economic factors that underlie the development of the respective clusters and (c) to help interpret the empirical data collected through the semi-structured interviews.

In order to obtain detailed empirical data on the cluster-building process and the organisations' networking activities in the cluster, semi-structured interviews have been carried out with five groups of major actors in the cluster. An interview guide divided into three parts (see Appendix 9) was prepared in advance to obtain information on the organisations' backgrounds, their involvement in the cluster and their specific linkages with other major actors in the cluster. From June 2002 to April 2003, about 60 interviews were conducted with a wide range of organisations in the ICT clusters of Hong Kong and Scotland (30 organisations in each region) (see Appendix 10 for letter of interview request). Each interview was conducted with one or two senior managers of the organisation (mainly technical directors or senior technology managers) and each interview lasted about 60-80 minutes. Most of the interviews were taped (except for those that failed to obtain consent from the interviewee) and transcribed afterwards (see Appendix 11 for sample of transcribed interview).

### 1.4.2 Justification for using a case study approach in this research

Yin (1984) defines case study as an investigation of a contemporary phenomenon within a real-life context and it should focus on a limited number of research sites or cases. The justifications for applying case study in this research are outlined below:

**Explain observed events, identify constructs and verify relationships**

Firstly, the decision to choose case study as the methodology is based upon the purpose of this research. Yin (1984) suggests that research questions focussing on the 'why' and the 'how' tend to use the case study method, as one of its strengths is in generating explanatory data on observed events. The desire to investigate how a cluster could be built by policy design makes the case study method an appropriate methodology for this research. Stoecker (1991) also contends that case study is particularly useful in developing process theory, while it is also a more effective methodology for showing cause and effect occurring over a period of time. In view of the above, case study can meet the objective of this research as its ultimate aim is to contribute to the theoretical understanding of cluster building processes through a longitudinal study of the 10 year development of two ICT clusters.

**Facilitate investigation on abstract concepts, ambiguity and less precise but deeper phenomena**

Secondly, this research on cluster building process covers a lot of complex and abstract concepts such as inter-organisational networks, knowledge flows and organisational learning, technological diffusion and spillovers, informal linkages, etc. These concepts are difficult to define and to measure by the quantitative method. Besides, this research involves an investigation of the social and cognitive dimensions of the major actors in the cluster. For example, it looks into the motives, perceptions and pursuits of various organisations participating in the cluster. Since case study allows the study of abstract concepts and less precise phenomenon while enabling the generation of more in-depth data, it is an appropriate methodology for this study.

**A free and wide choice of methods enables holistic study of complexity**

Thirdly, cluster building is a complicated process and it cuts across many traditional policy areas, including education and training, business and industry, infrastructure, etc. Hence, this research adopts a multi-disciplinary (including economics, management, sociology, politics) approach and applies a multi-method (including a combination of archive and interview-based analysis) to obtain a more rounded and multi-dimensional (e.g. economic, knowledge and social) picture of clusters. As case study allows a free and wide choice of data generation methods and analysis techniques, it is particularly suitable for tackling complicated research problems such as the cluster building process. It allows flexibility in approaching the research problem from different perspectives so that the findings can be interpreted in a holistic way.

**Contemporary focus, capture the cluster building process**

Finally, case study is the preferred method in examining contemporary events. Since the chosen clusters for analysis in Scotland and Hong Kong have only emerged in the past few years, there are limited archive records and research data on them. Also, cluster building is a dynamic and evolving process. Through conducting interviews with the management of the organisations involved in the cluster, it is possible to obtain the latest information on a specific organisation's networking activities in the cluster and to capture the most up-to-date development of the cluster building process. Besides, this method also helps us avoid the predominantly retrospective reporting found in other cluster studies.

### 1.4.3 Justification for using an archive approach to complement the case study approach

**Archive** is a record or a set of records of the past events, which can either be in the form of documents in texts, graphics or quantitative statistical data. (Robson, 1998) Archive records play an important role in this research as they provide information on the contexts of the two regions and on the backgrounds of the organisations being investigated, which is of help when interpreting the findings. However, a purely archive-based analysis is seen as inadequate in this research for a number of reasons. First, archives are records produced by other researchers for other purposes and do not directly address the aims and objectives of this research. Second, archives deal mainly with historical issues, so that information on current issues such as a cluster's latest development is not always available. Lastly, data on abstract issues like networking activities, knowledge flows and informal networks are usually not well- documented in archives and so need to be collected by other means. Therefore, archive analysis alone is inadequate and must be complemented by semi-structured interviews in this research. (see Appendix 3 for the full version of the methodologies applied in this research)

## 1.5 Structure of this thesis

| Part | | Chapter | Title | Content |
|---|---|---|---|---|
| I. | Introduction | **1** | Introduction | To introduce the research problem, the methodology of the thesis and to provide justifications for this research |
| II. | Literature review | **2** | Theoretical framework of this thesis | To compare different approaches for studying clusters and to identify an appropriate theoretical framework for this research |
| III | Methodology | **3** | Research design and methods | To outline the research design and methods applied in this thesis |
| IV | Empirical data | **4** | Development of ICT cluster in Scotland | To illustrate the 'process' of cluster building in Scotland at the 'meso level' and to evaluate its success and failure |
| | | **5** | Development of ICT cluster in Hong Kong | To illustrate the 'process' of cluster building in Hong Kong at the 'meso-level' and to evaluate its success and failure |
| V. | Data analysis | **6** | Cross-country study of ICT clusters in Scotland and Hong Kong | To compare the similarities and differences between the cluster building processes in Scotland and Hong Kong at the 'meso-level' and draw out common good practices for cluster building processes |
| VI. | Conclusions | **7** | Conclusions and implications | To provide answers to the research questions and draw out policy implications for Scotland and Hong Kong |

## 1.6 Delimitation of scope

### 1.6.1 Explicit boundary of the research problem

This research only covers the geographically concentrated industrial clusters despite the fact that the so-called ‘virtual clusters’ based on virtual or extended enterprises are becoming increasingly popular in the global business environment. The decision to not cover virtual clusters in this research is made after a consideration of the following factors:

Firstly, the study of geographically-based industrial clusters is justifiable since many researchers have shown that geography is still important in business. For example, Gertler et al (2000) argue that personal contact encouraged by spatial proximity is a necessary condition for cooperation and market transactions as it stimulates the generation of trust and common cultural and institutionalised rules of conduct. Lundvall and Johnson (1994) also suggest that spatial proximity is an essential condition for the diffusion of knowledge through learning-by-interacting, as knowledge in both tacit and explicit forms are better communicated under the same geographical context. Also, this study aims to look at the cluster building process by public policy design, and as policy in Hong Kong and Scotland is still largely geographically based, this also justifies the choice of geographically-based clusters for this study.

Secondly, recent studies on virtual environment show that the interactions in the virtual space are very different from those that take place in the traditional economic and social spaces. Diemers (2000) states that virtualisation has led to a major re-conceptualisation of organisation roles, norms and cultures. Therefore, the study of the interaction or networking activities through mediated forms of communication, such as the internet, yields a very different approach and this may cause a number of methodological problems in this research. Although ‘virtual cluster’ is an interesting topic to pursue, it is considered beyond the scope of this study.

### 1.6.2 Other limitations

**Limitation on the industry chosen**

One of the imitations of this research is that it is confined to the study of one technological sector. Although a comparative study on several technologies may produce a more fruitful picture of the cluster development in different sectors and may shed light on the specific technology-related factors that have impacted on the cluster creation, the choice of focussing on one technological sector is also justified. Since each technology has different characteristics, such as level of maturity and patterns of networking activities (Pavitt, 1984), this will, in turn, have an impact on the cluster building process. This would result in an excessive amount of work in interpreting the data and would also make it more difficult to identify common 'good practices' in cluster building. In addition, policy makers see both Hong Kong and Scotland as having major competitive strengths in their ICT sectors.

**Limitation of the locations chosen**

Another limitation of this research is on its choice of locations. In fact, the identification of clusters is problematic, as cluster analysis can be carried out at different levels, ranging from company level to international level. However, national and international levels are considered as too broad to draw out the boundaries (Nelson, 1993). The cluster analysis in this research focuses on the regional level as this level is not only more manageable, but also enables us to identify geographical factors at play in the cluster (Cooke et al., 1997). The comparison between Scotland and Hong Kong is appropriate given their similarities in population size, economic composition, industrial structure, level of administrative autonomy from central government and the fact that both regions have developed a strong ICT sector over a period of more than 30 years. Moreover, since Scotland has a longer history of cluster development than Hong Kong, its experience can be a useful comparative benchmark in this study.

**Limitation of the methodology chosen**

Last but not least, one of the most often-heard criticisms of case study is on its limitations in generalising the results to the whole population. While generalising the results is not the intention of this research, its aim is to enhance our theoretical understanding of the cluster building process and generate useful insights that will be of help to the specific cluster-building processes of Hong Kong and Scotland. Moreover, the findings based on semi-structured interviews have a high degree of soundness for four reasons: first, all of the interviewees were carefully selected from the respective clusters and represent a wide range of organisations in the cluster. Second, multiple interviews (60 interviews in total) were carried out following the principle of replication, so that the weaknesses of using a small number of cases could be overcome. Third, attention has been paid to the context of the regions and the background of the organisations to help increase the accuracy of interpretation of the interview data. Finally, the findings are triangulated through the comparative analysis of the two ICT clusters, thus enhancing the validity of the study.

### 1.7 Chapter Summary

This chapter introduces the Ph.D. research aimed at increasing the understanding of the cluster-building processes. In particular, this study tackles the research problems of **how such clusters can be purposively built by policy design** and **what the processes involved in their build-up are.** Four basic research questions have been raised and justifications for this research have been provided. In order to provide answers to these research questions, an empirical research based on the comparative study of the cluster building process of two emerging ICT clusters in Scotland and Hong Kong, respectively is introduced. The methodology and its justifications are briefly described in section 1.4. An interview-based case study is carried out to obtain empirical information on organisations' involvement in the cluster and their respective linkages with other major actors in the cluster. The interviews are grounded on the contextual information generated by archive research about the two regions and the organisations' backgrounds. This introductory chapter has also outlined the boundaries and other delimitations of this research, as well as the justifications for these delimitations.

# Chapter 2 Theoretical framework of this thesis

**Objective: to compare six theoretical approaches which are of direct relevance for studying clusters and to identify an appropriate framework for this thesis.**



## 2. Introduction

*The full version of the literature review on further concepts and schools of thought of relevance to the discussion on the nature of clusters can be found in Appendix 1. A summary of these concepts is provided in section 2.5. In turn, Appendix 2 reviews the six approaches that are directly relevant to the study of clusters. This chapter just concerns with the comparison of six approaches with the purpose of identifying a theoretical framework for this thesis.*

Although the term 'cluster' has only become popular over the last two decades, the phenomenon of regional agglomeration of a particular industry has existed since the 17$^{th}$ century. According to Steiner (1998), the development of clusters was particularly common after the industrial revolution. For instance, steel and shipbuilding clusters could be found in Glasgow, watches in Switzerland, machinery in Southern Germany, etc. As time went on, some of them declined, such as the shipbuilding in Glasgow, while many others, especially those associated with the high tech industries such as the computer and electronic industries in Silicon Valley and Route 128 in the USA, emerged as new clusters. The research by

Castells and Hall (1994) shows that many of the world's high technology innovations still come from traditional industrial cluster areas such as Tokyo, Paris and London.

The growing economic importance of clusters in recent decades has attracted many scholars to research this phenomenon. However, the study of clusters as a theoretical concept has given rise to much confusion and difficulties. Particularly, such confusion has stemmed from the diverse nature and types of clusters in different places. For instance, a cluster can be constituted by a regional agglomeration of small firms (like clusters in Italy), or by a group of allied large and small firms (like clusters in the US), or by a large central firm holding many small subsidiary firms (like clusters in Japan). It may emerge naturally from 'bottom up' (like Silicon Valley in the US), or be created 'top down' by government design (like Hsinchu Industrial Park in Taiwan), or by a mixed form of public-private cooperation (like clusters in Scandinavian countries). Also, many scholars use different terms to refer to the phenomena akin to industrial clustering, such as 'technopoles', 'national systems of innovation', 'regional systems of innovation', 'technological systems' and 'sociotechnical constituencies'. Although these terms point to features similarly observed in clusters, the theoretical concepts associated with these terms originate from different disciplines, and are derived from the results of cluster research at different levels, based on different methods and with different analytical focuses. As Martin and Sunley (2003) point out:

> *'The [cluster] concept has acquired such a variety of uses, connotations and meanings that it has, in many respects, become a 'chaotic concept', in the sense of conflating and equating quite different types, processes and spatial scales of economic localisation under a single, all-embracing universalistic notion.'* (Martin and Sunley, 2003, p.10)

It is the objective of this chapter to clarify some of the confusion existing around the concept of 'clusters' by systemically reviewing and comparing different cluster approaches. Section 2.1 outlines the background of the six 'new' cluster approaches chosen for comparison in this chapter. In section 2.2, the six approaches to clusters are compared with each other with the aim of identifying the similarities and differences, as well as the relationships among them. In section 2.3, a theoretical framework that integrates the insights from different cluster approaches is proposed and the justifications for using this framework in the empirical research of the ICT clusters in Scotland and Hong Kong are given in Section 2.4. Section 2.5 summarises some of the key concepts of relevance to the discussion on the nature of clusters. Finally, a chapter summary is presented in section 2.6.

## 2.1 Background for 'new' cluster theories

Feser (1998) points out:

> *'There is no theory of industry cluster…there is instead, a variety of old and new theories of (1) the interrelationships between economic actors that clusters describe, and (2) the implications of such interrelationships for economic growth and development.'* (Feser, 1998, p.19)

According to Feser, the 'old' theories of clusters can be traced back to Smith (1925) [1776], who firstly hinted that globalisation is a precondition for regional specialisation leading to higher productivity. Another early apologist of cluster theory, List (1916) [1841] advocated a broad range of policies to facilitate knowledge diffusion and the application of new technology to accelerate industrialisation. Marshall's (1890) 'industrial district' can be regarded a cornerstone of both 'old' and 'new' cluster theories. He theorised the dynamics of external economies in association with learning, innovation and specialisation in an industrial region. Schumpeter (1939) pointed out that the emergence of innovation clusters at specific periods is like a series of waves. However, he was not too concerned with the spatial dimension of these innovation activities. Perroux's concept of growth pole (1950) also had a clear relation to modern cluster theories. His idea inspired the 'filière' approach in France in the 1970s and the GREMI (Group de Recherche Europeen sur les Milieux Innvoateurs) in the 1980s in their respective studies of innovative environment/milieu.

More recently, in the 1990s, Porter (1990) developed a systemic framework to study clusters. His work marks the beginning of the 'new' cluster theories and has led to a revival of interest in clusters by many scholars from different research disciplines. A number of ideas in these 'new' cluster theories are associated with the development of high tech industries, national competitiveness and regional economic renewal and regeneration, thus attracting the interest of many national and regional governments in the world, who are keen on borrowing the insights from these cluster theories and incorporating them into their economic or industrial strategies. However, Martin and Sunley (2003) raise the following concern:

> *'The mere popularity of a construct is by no means guarantee of its profundity. Seductive though the cluster concept is, there is much about it that is problematic, and the rush to employ "cluster idea" has run ahead of many fundamental conceptual, theoretical and empirical questions.'* (Martin and Sunley, 2003, p.5)

This chapter focuses mainly on comparing the 'new' cluster theories, as they are more relevant to the research problem of this thesis. It reviews six cluster approaches. They are:

1) national systems of innovation (NSI) (Freeman, 1987; Lundvall, 1992; Nelson, 1993), 2) regional system of innovation (RSI) (Cooke and Morgan; 1994; Cooke et al., 1997; Braczyk, et al., 1998), 3) sectoral innovation systems (SIS) (Breschi and Malerba, 2000; Mowery and Nelson, 1999), 4) industrial clusters (IC) (Porter, 1990; 1998), 5) technological systems (TS) (Carlsson and Stankiewicz, 2000; Carlsson and Eilasson, 2001), and 6) sociotechnical constituencies (STC) (Molina, 1993; 1999; Molina and Kinder, 2001).

There are numerous theories identifying the clustering/systemic nature of technological development, for instance, technopole (Castells and Hall, 1994), flexible specialisation (Piore and Sabel, 1984), regional production system (Scott, 1998) and local industrial system (Saxenian, 1994), technological systems (Hughes, 1983), actor networks (Callon, 1989), to name only a few. However, the decision to choose the above six cluster approaches for a critical review is made for three reasons. First, each of the above-mentioned six approaches offers a systematic framework for the study of clusters, while many other cluster theories tend to lack the conceptual instruments for the systemic analysis of the nature and dynamics of clusters. Therefore, the above six approaches can meet the objective of this chapter by helping choose a theoretical tool to study clusters. Second, the above six approaches come from different theoretical disciplines and represent different perspectives. For example, the NSI, RSI and SIS approaches come from the institutional/hierarchical perspective, the IC approach comes from the neoclassical/market perspective, while the TS and STC approaches come from the network/cluster perspective (Kemp, 2002; Midttun, 2002) This broad range of concepts and ideas in different theoretical disciplines is useful to help counteract the 'bounded rationality' affecting the choice of an appropriate framework. Third, the six cluster theories have already covered a number of important and useful concepts from other cluster theories, even though some of the authors may not have directly made reference to the work of others. For example, the RSI approach has incorporated concepts like 'technopole' (Castells and Hall, 1994), 'untraded interdependencies' (Storper, 1995) and 'learning region' (Florida, 1995). The IC approach has incorporated concepts like 'increasing return of externalities' (Krugman, 1991). The TS approach has incorporated concepts like 'large technological system' (Hughes, 1983; 1986), while the STC approach has incorporated concepts like 'actor networks' (Callon, 1986), 'heterogeneous engineering' (Law, 1987) and 'social construction of technology' (Pinch and Bijker, 1984). Consequently, the author is confident that the chosen six cluster approaches mitigate the problem of neglecting other cluster theories due to the limited space of this thesis.

## 2.2 Comparison among different cluster approaches

*The six cluster approaches are discussed separately in Appendix 2, including an analysis of their theoretical roots and weaknesses. This chapter just concerns with the comparison of these six approaches and the selection of theoretical framework for this thesis.*

The six approaches dealt with are similar in some ways but different in others. Sometimes they point to similar features of clusters, although looked at from different levels or angles. This situation is very much like the old parable of the three blind men touching an elephant. The elephant is so big, each of them only manages to touch one part of the elephant. By the end, each of them has a very different imaginary picture of the elephant.

Similar lessons can apply to the research on clusters. As clustering of innovation activities is such a complicated phenomenon, researchers look at it from different levels, examine it from different empirical cases and apply different conceptual tools and so may get very different pictures of it. It does not necessarily mean that their approaches are incorrect or contradictory to each other. In many cases, they may complement each other and enrich our understanding of clusters. Therefore, if we can apply a conceptual tool which integrates these insights from different approaches, the chances of us getting a picture of clusters which is closer to reality will be higher.

### 2.2.1 Similarities among the six cluster approaches

Since the six approaches mentioned above owe their differences to their theoretical origins and analytical focuses, their illustration of clusters demonstrates a certain level of variation. However, a number of common features can still be identified from the six approaches.

**1. On the geography dimension**

First, all six approaches point out the relevance of geographical dimension to clusters, even though the degree of importance and the role played by geography differs in each approach. For instance, with regard to the geography-based approaches, the role of geography is obviously dominant. The NSI and RSI approaches highlight at least five roles played by geography either at the national or regional level. They are: 1) historical incidents and economic structures provide the setting or context for the innovation environment (Lundvall, 1992; Nelson, 1993). 2) infrastructures and institutions support the innovation activities taking place (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Cooke et al., 1997). 3) common habits and values facilitate the exchange of information and learning (Lundvall, 1992; Cooke et al, 1997). 4) national or local cultures reduce uncertainty and generate trust (Lundvall, 1992; Cooke et al., 1997). 5) geography defines the boundary of government innovation policies (Freeman, 1987; Nelson, 1993; Cooke et al., 1997).

In contrast to the geography-based approaches, the technology-based approaches tend to focus on a specific sector or industry. It does not mean that these scholars do not pay any attention to the role of geography in clusters. For example, in the SIS approach, Breschi and Malerba (2000) explicitly point out that geographical proximity can facilitate the transmission and communication of knowledge, so that innovators tend to concentrate on one specific location. However, the SIS approach suggests that the location of innovation activities not only depends on the number of geographical factors, but also on the characteristics of the technology that may impact on the location decision. In the IC approach, Porter explicitly points out: '*Differences in national economic structures, values, cultures, institutions and histories contribute profoundly to competitive success.'* (Porter, 1990, p.19) In particular, Porter stresses the role of geography in defining the characteristics of 'home nations' such as the 'sophisticated home market' and 'aggressive domestic rivalry'. He regards the role of geography as providing a competitive environment to drive innovation to occur. Regarding the TS approach, the geography dimension is implied as an intrinsic feature of a technological system. In fact, Carlsson and Stankiewicz (2000) define a technological system as '*a dynamic network of agents interacting in a specific economic/industrial area*' (Carlsson and Stankiewicz, 2000, p. 223) and they perceive the role of geography as the setting for sourcing various resources (i.e. competence) for innovation activities. Finally, although the STC approach has not explicitly described the role of geography, the geographical dimension of a sociotechnical constituency has been hinted at in the 'governance' and 'cluster and industrial trends and standards' of the STC diamond. A sociotechnical constituency cannot exist in the air. The 'governance' dimension implies the management of the alignment between the technological change and the wider industrial and market environment. Similarly, 'cluster and industrial trends and standards' also imply that the technological development in the sociotechnical constituency has to follow some regulations or restrictions set in the wider economic environment. This delimits a sociotechnical constituency with a boundary, not excluding a geographical one.

**On the institutional dimension**

Another similarity of the six approaches is in the institutional dimension. Institutions have played important roles in the six approaches, even though not all of them originate from the institutional perspective (except NIS, RIS and SIS). It is interesting to note that different scholars apply different definitions to 'institution' and they perceive the role of institution differently. Basically, institutions in the six cluster approaches include or refer to five different things: 1) physical infrastructure, such as telecommunication infrastructures, transportation (Cooke et al., 1997). 2) organisations and the resources/competence embedded within, including firms, university and public research organisations, financial organisations, etc. (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Cooke et al, 1997; Porter, 1990; Carlsson and Stankiewicz, 2000; Breschi and Malerba, 2000; Molina, 1993). 3) values, routines and habits (Lundvall, 1992; Cooke et al., 1997; Carlsson and Stankiewicz, 2000). 4) governance and regulations, including governance structure and mode of interaction, i.e. rules of games (Cooke et al., 1997; Breschi and Malerba, 2000; Molina, 1993) and 5) innovation/industrial support policy programmes (Freeman, 1987, Nelson, 1993; Porter, 1990; Carlsson and Stankiewicz, 2000).

These six approaches have also identified a range of similar structural elements making up a competitive cluster. They are: 1) institutions supplying factors of production to innovation, especially the financial resources (Lundvall, 1992, Cooke et al., 1997; Carlsson and Stankiewicz, 2000; Molina, 1993). 2) institutions providing internal and external knowledge to innovation, including the R&D department of the firms and other organisations, such as customers, other firms in the industries and competitors (Lundvall, 1992; Cooke et al., 1997; Porter, 1990; Carlsson and Stankiewicz, 2000; Breschi and Malerba, 2000, Molina, 1997). 3) institutions supporting knowledge creation, such as universities and public research organisations (Freeman , 1987; Lundvall, 1992; Nelson, 1993, Cooke et al., 1997; Porter, 1990; Carlsson and Stankiewicz, 2000, Breschi and Malerba, 2000; Molina, 1993) and 4) institutions providing policy support and control, particularly the government (Freeman, 1987; Lundvall, 1992; Nelson, 1993, Cooke et al., 1997; Porter, 1990; Carlsson and Stankiewicz, 2000, Breschi and Malerba, 2000; Molina, 1993). The following table shows the common structural elements highlighted in these six approaches:

Table 2.1 Common structural elements in the six cluster approaches

| Institution | NSI | RSI | SIS | IC | TS | STC |
|---|---|---|---|---|---|---|
| **Factor of production** | Techology, innovative firms and R&D organisations, financial sector | Technology, innovative firms and R&D organisations, financial infrastructure | Entrepreneurial dynamics (e.g. ideas, innovators, entrepreneurs, venture capitals, industrialists) | Factor condition (natural, human and capital resources) | Development bloc (technology) and competence bloc (innovators, entrepreneurs, VCs, industrialists) | Material, human, financial, space, time resources |
| **Internal & external knowledge** | User-producer relations, Internal organisation of firms & inter-firm relationships | Firms' formal & informal networks | Technological opportunities, Knowledge cumulativeness of firms, nature of knowledge base | Demand condition, Firm strategy, structure and rivalry | Economic competence of firms, networks of actors | People-human resources (e.g. design engineers, management) and organisations (e.g. other companies, consumers) |
| **Knowledge creation support** | R&D intensity & R&D organisations | Knowledge centres | Population of innovators, spatial boundary of innovation activities | Related and support industry | Technology community | Organisations & institutions- (e.g. universities and technical institutions) |
| **Public policy support** | Role of public support | Regional governance structure | Government regulations influencing appropriability of technology | Government | Political system, legislative system | Governance-Government & legislation |

## 2. On network and knowledge dimensions

All six approaches address the network dimension of clusters. Generally, they all agree that one of the basic functions of networks is transmitting and communicating knowledge. However, the authors of the six approaches put their analytical focus on different kinds of networks and, therefore, they highlight a variety of functions of networks in clusters. For instance, the NSI approach stresses the importance of knowledge networks, especially the ones between users and producers, and sees those as the main conduit for interactive learning to take place. (Lundvall, 1992; Johnson, 1992) Although the RSI approach does not deny the importance of knowledge networks, it tends to pay more attention to the social networks.

Cooke et al. (1997) stress the importance of social networks in creating an innovation culture/milieu, within which local learning capability and collective order can be developed.

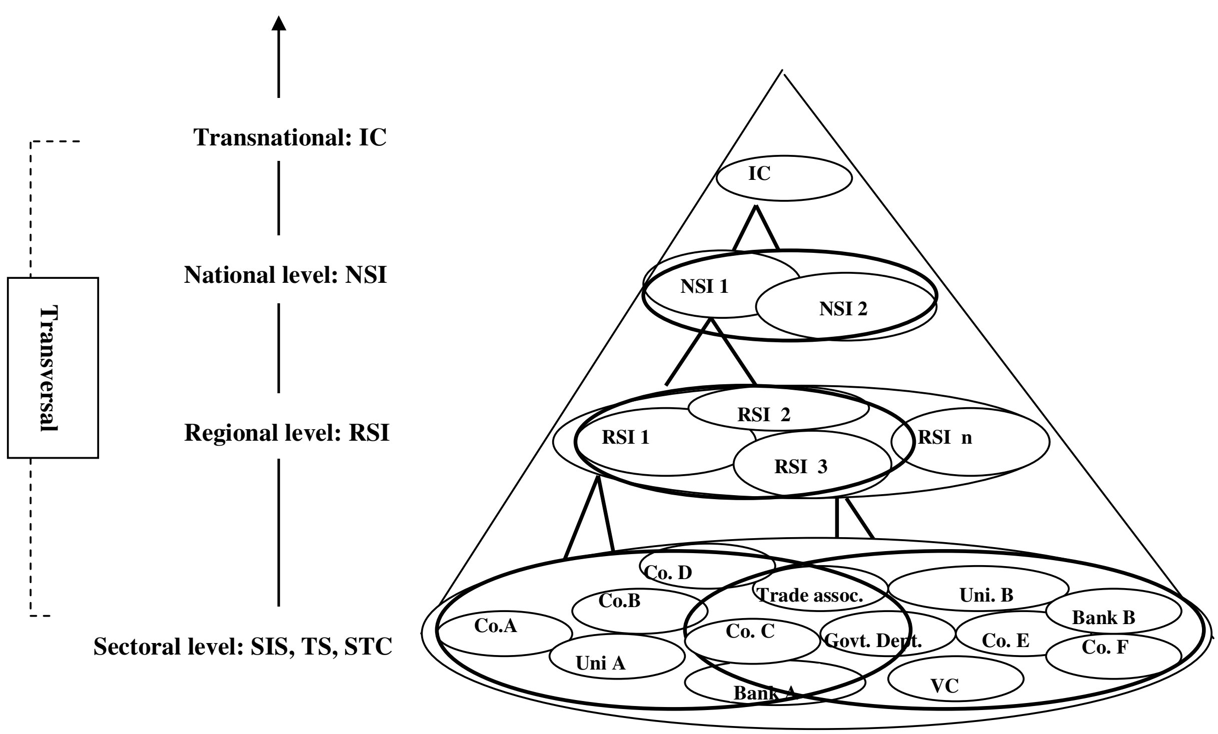
In the SIS approach, the nature of networks depicted by Breschi and Malerba (2000) is a technological one. Sharing a similar view with the NSI approach, they also regard networks as important channels for knowledge transmission and exchange. They add that the characteristics of the technology itself may sometimes determine the pattern of interaction and spatial boundaries of these networks. In the IC approach, Porter (1990) points to the economic networks that exist between buyers and sellers (demand conditions). This is similar to the NSI's 'user-producer relations'. However, it seems that Porter puts more emphasis on buyers' roles of generating incentives and pressures for innovation, rather than learning between buyers and sellers, although he does not ignores the importance of the information exchange between them. Regarding the TS approach, Carlsson and Stankiewicz (2000) refer to the socioeconomic nature of networks in a technological system, which sees them act as 'technological communities'. Carlsson and Eliasson (2001) particularly highlight the crucial role of entrepreneurial networks in innovation, which act as an interface for the technology demand and supply sides, turning technological opportunities into business opportunities. Finally, the nature of networks in the STC approach is a multi-dimensional one as it embraces a number of social, economic, political and technical features. Molina (1993), in particular, highlights the critical roles played by technology networks and social networks. The functions of technology networks, for example, do not only limit to the transmission and communication of knowledge, but they also help define the patterns of sociotechnical change through firms' strategies or routines (as suggested by the regime approach). Social networks perform the functions of pulling and integrating resources (similar to the TS approach) by supplying incentives to innovation (i.e. by defining their goals and changing perceptions) and providing governance to the overall constituency building process.

### 2.2.2 Differences among the six cluster approaches

#### 1. Level of analysis

Despite the similarities mentioned above, the six cluster approaches do show significant differences in their description of clusters. Though the reasons contributing to this are numerous (as already mentioned – namely, different theoretical backgrounds, different case studies from different countries, different interpretation of researchers, different types of cluster etc.), one of the factors leading to this may be the differences in the scholars' levels of analysis. To explain this difference, the following figure based on the analogy of flying a helicopter may be helpful.

Figure 2.1 'Helicopter overview' of different cluster frameworks




Scholars standing at different levels to look at clusters may also get a different picture. For example, the NSI approach tends to look at clusters at a national level. Lundvall (1992) sees a national system as the nation's infrastructures supporting the innovation activities of a nation in general. By contrast, the RSI tends to focus on the regional level. As Cooke et al. (1997) point out, differences between national and regional institutions and cultures may exist, while learning and innovation capabilities are sometimes determined by a regional innovation system instead of a national one.

Breschi's and Malerba's (2000) sectoral focus is clearly shown in their empirical studies of particular industries, such as microelectronics, auto and mechanical industries. However, a sectoral innovation system is not confined only to one level. It may exist within a region/nation or across several regions or nations. Porter (1990) seldom specifies the boundary of his clusters explicitly, as he stresses: '*the geographical scope of clusters ranges from a region, a state, or even a single city to span nearby or neighbouring countries*.' (Porter, 2000, p.15) However, his case studies tend to reflect a sectoral or industrial focus, and these 'sectoral' clusters can exist either in a nation (such as Japan's electronics industry) or in a region (such as California's wine industry, or Hollywood's film industry). Carlsson and Stankiewicz (2000) choose a technology or product as the focus of their analysis of a technological system, such as factory automation or electronics and computers. However, such a system may or may not take place within a specific geographical location. More importantly, the boundary of a technological system may enlarge or change from a regional level to a national one when the system evolves. Last but not least, the level of analysis of Molina's (1993) STC approach can be regarded as a multi-level one. Although the STC approach puts technology at the centre of a sociotechnical constituency, it does not mean that it is the sole focus of the approach. The STC approach also highlights the importance of intra-organisational level (firm/project level), inter-organisational level (cluster level), as well as the market level (regional/national level). The STC approach sees that these three levels are interrelated and co-evolving together. In short, SIS, TS and STC approaches have a sectoral focus but can be transversal to the regional-national-transnational levels.

## 2. Key concepts and cluster dynamics

Although the six approaches share a common understanding that clusters are important to innovation activities, they differ in the explanation of what kind of contribution clusters have made to innovation and how that contribution has been made. With regard to the NSI approach, the main contribution of clusters comes from the national infrastructure such as the R&D organisations, education systems, and financial sector etc. (Freeman, 1987; Lundvall, 1992; Nelson, 1993) The dynamics in a cluster are generated through the linkages and learning processes among the relevant institutions within the industrial structure and result in the reproduction of new knowledge. In addition, national, cultural, social and historical factors are also important to such dynamics. The RSI approach addresses the role of clusters as generating collective orders in a regional economy. (Cooke et. al., 1997) Such collective orders contribute to innovation in terms of facilitating learning and in the provision of social governance. The cluster dynamics of a regional innovation system come from the innovation milieu, within which reflective learning and associative relationships based on trust can be achieved.

Similar to the NSI and RSI approaches, the SIS approach also see clusters as a location where knowledge externality from other firms and universities or research institutions is available, and this will particularly be the case when the knowledge is in tacit form. However, in contrast to the NSI and RSI, Breschi and Malerba (2000) point to the role of entrepreneurs in the creation of cluster dynamics. In particular, they highlight the competition among entrepreneurs in the selection environment— the market. The winning companies will establish a dominant position in the market while the failing ones will exit. In the IC approach, Porter (1990) attributes the role of clusters in creating an environment which reinforces the interaction among the elements in the 'competitive diamond'. The cluster dynamics derive from the combined force of cooperation and competition, which drive companies to innovate constantly so as to differentiate themselves from their rivals and to establish a strategic positioning in the market. With regard to the TS approach, Carlsson and Stankiewicz (2000) see clusters as a socioeconomic setting for a network of social actors to interact and enrol the necessary resources/competence for the development of a specific technology. The cluster dynamics are generated through an entrepreneurial selection process through which an entrepreneur selects and takes forward a winning technology into a business, attracts a critical mass (including VCs and industrialists) and builds up momentum for its further development. Finally, in the STC approach Molina (1993) sees a sociotechnical constituency as a setting or environment for capturing a range of technical and social constituents, including the nature and characteristics of technology and the diversified goals, perceptions and actions of the social actors to develop a technological capability. The dynamics of the sociotechnical constituency is generated through purposive alignment and re-alignment processes among technology, people and institutions, so as to overcome the obstacles in the technology development processes. The successful attempt at alignment will re-configure social actors' values and goals and/or re-structure institutions and systems. Table 2.2 attempts to summarise and illustrate the differences in the key concepts of these six cluster approaches.

Table 2.2 Comparison of analytical focus and key concepts among the six cluster approaches

| | **Level of analysis** | **Nature of networks** | **Context** | **Content** | **Process** | **Dynamics** |
|---|---|---|---|---|---|---|
| **NSI** | Nation | Knowledge, cooperative | Infrastructure, public polices, national history | Institutional set up, habit and rules, knowledge flow | Networking and interactive learning | Reproduction of new knowledge |
| **RSI** | Region | Social, cooperative | Infrastructure, regional culture and local governance | Institutional set- up and governance, knowledge flow, social order | Networking, reflexive learning and collective order | Informal governance and innovative milieu |
| **SIS** | Sector | Technological cooperative+ competitive | Technological regime and Schumpeterian Mark I or II selection environment | Source of knowledge, geographical distribution of innovators | Networking and knowledge externality, technology life cycle, and Schumpeterian competition | Innovators' dynamics, company entry and exit |
| **IC** | Sector | Economic, cooperative+ competitive | Competitive environment | Resources, economic agents, supporting institutions | Networking and market competition (esp. home demand) | Combined force of cooperation and competition, firm strategies |
| **TS** | Technology or product | Socioeconomic, cooperative +competitive | Development blocks and technology opportunities | Technological community, competence bloc | Network of actors, integration of competence blocks | Entrepreneurial selection, critical mass and momentum |
| **STC** | Multi-levels | Sociotechnical, cooperative +competitive | Technological capability, materials, social actors, competing technologies, governance structures | Knowledge networks, divergent interests and goals of actors, management of relations | Alignment and re-alignment of goals and actions, technology to people and people to governance | Social actor goal and value reconfigured, institution and system restructured<br>Constituency-builders as sociotechnical aligners |

### 3. On the 'functional' level

Johnson (2001) proposes to use the concept of 'function' to assess the commonalities and differences among different innovation systems and she broadly divides the functions of innovation systems into ten categories. These include identifying problems, the creation of new knowledge, supplying incentives, supplying resources etc. Although her framework is originally for the comparison of three innovation systems only[1], it provides useful guidelines for illustrating the differences among the six cluster approaches on a 'functional' level. The results are exhibited in Table 2.3.

Table 2.3 Comparison of different functions among the six cluster approaches

| Functions | NSI | RSI | SIS | IC | TS | STC |
|---|---|---|---|---|---|---|
| 1. Identifying problems | | | | √ | √ | √ |
| 2. Creating new knowledge | √ | √ | √ | √ | √ | √ |
| 3. Supplying incentives | | | | √ | √ | √ |
| 4. Supplying resources | √ | √ | √ | √ | √ | √ |
| 5. Provision of guidance for searching | √ | √ | | √ | | √ |
| 6. Recognising the potential for growth | | | √ | √ | √ | √ |
| 7. Facilitating knowledge & information exchange | √ | √ | √ | √ | √ | √ |
| 8. Stimulating and creation of markets | | | | √ | √ | √ |
| 9. Reducing social uncertainty | √ | √ | √ | √ | | √ |
| 10. Counteracting resistance to change | | | | | | √ |

[1] Johnson (2001) applies the 'functional' approach to compare 1) the national systems of innovation approach 2) the technological systems approach, and 3) the network approach and development block approach. The author of this thesis has borrowed Johnson's framework to compare the six cluster approaches and the results presented here are different from hers.

As shown from the table above, the functions highlighted by the six cluster approaches are more or less the same and they do not show remarkable differences at the 'functional' level. The most frequently mentioned functions of clusters are: 1) creating new knowledge 2) supplying resources and 3) facilitating information and knowledge exchange. The first function is very much in line with the common objective of the six cluster approaches in supporting the generation of innovation. The second function is related to the institutional dimension, as much of the resources for innovation are embedded in institutions. Examples of resources for innovation are the 'factor conditions' of IC, the 'role of financial sectors' in NSI and RSI, the 'economic competence' of TS and so on. The third function is relevant to the network dimension of clusters. For example, as mentioned in the IC approach, networking with sophisticated customers offers the best opportunities for transmitting information about emerging needs and technologies. The NSI and RSI approaches also emphasise user-producer interactions in communicating potential technical opportunities and user need. The details of these common functions have already been covered in section 2.2.1, and hence need not be repeated here.

However, the six approaches do show slight differences in certain functional areas. Some theories mention certain functions, but not others. The diversity on a functional level also shows that some functions of clusters tend to receive less attention from scholars. However, these 'less often mentioned' functions still deserve our attention, as they may suggest some aspects of the clusters that are under-researched.

**(a) origins of clusters and the importance of 'purposiveness'**

First of all, not many cluster approaches have explained the origin of innovation activities. In some cluster approaches, such as NSI, RSI and SIS, technological change is regarded as a given condition, and they do not explain why innovation comes about in the first place. IC, TS and STC approaches regard the origin of innovation as coming from the identification of a problem and/or opportunity. Porter (1990) cites the case of Japan, and points out that the need to overcome its disadvantages in the factor of production drives Japanese companies to innovation. Carlsson and Stankiewicz (2000) treat the problem as 'structural tensions caused by development blocks'. Molina (1993) regards it as the 'target problem' driven by technological or socioeconomic reasons. He gives particular attention to the function of 'identification of a problem' as it gives a goal or purpose to cluster builders to 'solve' the identified problem with deliberate actions. However, NSI, RSI and SIS approaches rarely state why innovation starts. As Lundvall et al. (2001) point out, a system of innovation is mainly used as an *ex post* rather than an *ex ante* concept. It tends to be used to describe and analyse innovation activities rather than explaining why it happens at the beginning.

**(b) Expectation and managing expectation**

Secondly, different cluster authors do show slight disagreement on certain functions of clusters, such as the 'supplying of incentives', 'providing guidance for searching', 'recognising the potential for growth', 'stimulating the creation of markets' and 'reducing social uncertainty'. It is worthy of note that these functions of clusters share one commonality—these actions are related to the perception and expectation of actors towards future events. Porter (1990) highlights that home market suppliers will have incentives to innovate when they foresee the domestic demand. Carlsson and Eliasson (2001) suggest that entrepreneurs and venture capitalists invest in technologies when they perceive business opportunities. Molina (1993) implicitly implies that social actors get incentives to develop a technological capability or accept a technological change when they expect it will bring benefits to them.

However, actors' perception or expectations do not always appear naturally. In fact, it is the need to manage these perceptions and expectations that provides clusters with a crucial role. Clusters can help actors to generate the perception and expectation to develop a technology, or to lead their perception in a certain direction through the 'provision of guidance for searching', 'recognising the potential for growth' 'stimulating and creation of markets' and the 'reduction of social uncertainty'. These four functions highlighted by respective scholars are closely related to each other. For instance, the function of 'guidance for searching' is relevant to 'reduction of social uncertainty', as providing guidance by means of guidelines or guideposts generally help reduce uncertainties. Similarly, 'recognising the potential for growth' is related to 'creation of new markets', as a growth potential will normally lead to markets. In short, the differences among the six cluster approaches actually depend on the authors' perception of 'where does the function of managing these future expectations reside' and 'how to do it'. Some approaches suggest that the role of managing these expectations resides on the structures and through influencing the technology supply side, while some other approaches tend to see the role as residing on the actors, and through better perception of the signals from the market side.

For instance, the NSI and RSI approaches tend to stress that the function of managing the expectations resides on the structures, i.e. the knowledge infrastructures. They perform functions such as providing guidance for searching and reducing social uncertainty from the structures by influencing the technology supply side. They highlight the function of clusters as providing an institutional setting to guide the searching activities (Lundvall, 1992; Johnson, 1992) or providing an innovative milieu to help reduce uncertainty through trustful relationships. (Cooke, et al, 1997) However, the SIS approach tends to perceive the function of managing perception as residing on the actors, i.e. the firm or the sector itself. Breschi and Malerba (2000) see this function being performed by improving the technology supply side. For instance, firms with a higher technological competence can better perceive and capture technological opportunities (recognising growth potentials) and can also reduce the perceived risk of imitation from other firms through better copy right protection.

Similar to the SIS approach, the IC approach also perceives the function to manage perception as being performed by the actors, just as Porter (1990) emphasises the importance of a firm's strategy to influence its microeconomic environment. However, in a difference to the SIS approaches, Porter (1990) sees the clusters' function as helping actors to recognise the signals from the demand side. He particularly highlights the presence of 'sophisticated customers' in clusters in giving signals or pressures for firms to innovate. He also adds that the presence of the other firms in the clusters can act as role models to mitigate the perceived risk of failure. The TS approach is similar to the IC approach in that both of them stress that future expectation or perception comes from the signals of the demand side i.e. through entrepreneurs who recognise the need of the market. However, TS tend to highlight the important function of structures in taking advantage of such market signals. In particular, Carlsson and Eilasson (2001) highlight the complementarity and interdependence of these institutions embodied with different competences in acting as a whole to pursue the business opportunities.

The STC approach highlights the equal importance of 'structures' and 'actors', as well as 'technology supply' and 'market demand'. Molina (1993) stresses that technological change is a complicated process; it is not only a process of coupling between the technology supply and demand sides, but also a process occurring at 'multi-levels' (i.e. artefacts, social constituents, structures). Therefore, focusing on technology supply alone or on the demand side, or on actors or structures limits the capacity of clusters to capture the full potential or opportunities of technology development. This in turn influences the effectiveness of clusters regarding the function of managing the perceptions or expectations of the actors. However, the balance between 'demand' and 'supply', 'structure' and 'actors' is hard to come by, as such a balance will not exist spontaneously. Therefore, STC also gives a role to cluster or constituency builders to strike a balance among these factors with deliberate actions. This may be done by purposive 'governance', such as by generating incentives for technological change, by actively shaping the actors' perceptions or by encouraging specific actions to be carried out and collecting feedback.

**(c) difficulties in building clusters**

Finally, the function of 'counteract resistance to change' is the function least-often mentioned by the cluster approaches. This may be due to the fact that many scholars tend to see the good side of clusters, and they pay less attention to the 'problematic' aspect of clusters (although Porter (1990) mentions the problem of 'lock-in' in clusters). However, the STC approach highlights that misalignment is in the very nature of the sociotechnical constituency. Technical factors are difficult to change, due to 'path dependency' and 'lock-in', and social actors are resistant to change due to their mindset, values and habits. As a consequence, conflict and power processes seem to be inevitable when inducing technological change. Molina's (1993) STC approach captures this 'problematic' nature of technological change and addresses the role of cluster builders (often the government) to counteract such resistance to change and to seek re-alignment of the constituent parts through purposive actions and policy programmes.

In short, the six cluster approaches are similar in recognising the relevance to clusters of the geography dimension, which provides a crucial setting or context for the cluster building process to take place. The six cluster approaches also refer to a set of similar structural elements (see Table 2.1) and highlight the importance of networking and knowledge transmission. However, the six cluster approaches also show differences in their level of analysis and in the application of key concepts and theoretical focus (see Table 2.2). The analysis of the 'functional' dimensions also reflects that these six cluster approaches have differences in explaining the origin of clusters, the management of future expectation/perception of actors, and the difficulties in building a cluster.

## 2.3 An integrated theoretical approach

As clustering of innovation activities is such a complicated phenomenon, researchers look at it from different levels, examine it from different empirical cases and apply different conceptual tools and so may get very different pictures of it. It does not necessarily mean that their approaches are incorrect or contradictory to each other. In many cases, they may complement each other and enrich our understanding of clusters. Therefore, if we can apply a conceptual tool which integrates these insights from different approaches, the chances of us getting a picture of clusters which is closer to reality will be higher.

This thesis chooses Molina's (1993, 1999) STC approach to be the core theoretical framework for the study of the ICT clusters in Scotland and Hong Kong. The justification for choosing this approach is grounded on two reasons: 1) The STC approach has integrated much of the insights and strengths of the other cluster approaches. 2) The STC approach is distinctive from other cluster approaches in illustrating the processual dimension of cluster building, which can help tackle the research questions of this thesis.

Molina and Kinder (2001) propose a conceptual tool to capture the integrated insights from IC, NSI and STC approaches. This framework is particularly useful in two ways: 1) to assess the 'context' of the clusters with reference to the IC and NSI approaches. 2) to analyse the 'content' and 'process' of cluster building with reference to the diamond of sociotechnical alignment. Although the integrated conceptual tool developed by Molina and Kinder (2001) only covers three cluster approaches, by building on the foundation of their findings, the relations and overlapping areas of the six cluster approaches mentioned in the previous section can be identified.

**1. Context of clusters**

As the comparative analysis in Section 2.2 illustrates, the key concepts of the IC and NSI are similar in some respects. In particular, the two approaches have identified a set of structural elements which support innovation. Even Lundvall (1992) admits this in the introduction of his book: '*The basic elements overlap [with the IC] but that their ordering is different*'. (Lundvall, 1992, p. 17)

Similar to the dimensions of 'factor conditions' and 'related and supporting industry' in the IC diamond, the NSI approach also outlines a number of important institutions that determine the generation, diffusion and use of innovation in a nation. Below are the important institutions that constitute a system of innovation of a nation, and the corresponding factors mentioned in the IC approach are listed in brackets:

- Internal organisation of firms (IC's firm structure)
- Inter-firm relationships (IC's firm strategy and rivalry)
- Role of the public sector (IC's demand condition & government)
- Institutional set-up of the financial sector (IC's factor condition)
- R&D intensity and R&D organisation (IC's supporting industries)

In addition, the RSI, SIS, TS and STC approaches also depict firms actively searching for and exploring new knowledge through their internal R&D department and other supporting organisations, such as universities and research institutes. (see Table 2.1) This resembles the dimensions of 'firm strategy and structure' and 'supporting industries' mentioned in the IC theory, as firms adopt a networking strategy to seek new knowledge inputs/competence from other supporting organisations. The networking activities also bring in a 'critical mass' (as described by the TS approach), which enables the collective learning process to take place (as suggested by the RSI approach). Molina and Kinder (2001) further describe the relation between the STC approach and the cluster context as identified by the IC and NSI approach, as follows: '*the process [of STC building] described are themselves part of, and circumscribed by, the broader elements identified by NSI and ICs*' (Molina and Kinder, 2001)

**2. Content of clusters**

The STC approach has covered many key elements that constitute the 'content' of a cluster, as referred to by the IC and NSI approaches. For instance, Nelson (1993), in the introduction of his book highlights that 'technological communities' and 'inter-industry differences' are the two key elements that account for the differences of national innovation systems. This is similar to the STC approach which differentiates 'technical' and 'social' constituents in a sociotechnical constituency. As regards the technical constituents, the STC approach highlights the nature and maturity of the technology (segment I of the diamond of alignment). In fact, this dimension is similar to the SIS approach, which stresses that the characteristic of a specific technology (i.e. technological regimes) is part of the reason for the 'inter-industry differences'. Also, the maturity of the technology connects with the technology life cycle mentioned in the SIS approach. Regarding social constituents, the STC approach emphasises the constituents' perceptions, goals, action and resources (segment II).

This dimension does not only refer to the role of key institutions in a cluster, as suggested by IC and NSI (RSI) approaches, but also bears a high degree of similarity to the concept of 'technological communities' of the TS approach, which highlights that different institutions are marked by their respective goals and competence.

### 3. Process of clusters

Central to the cluster building process of the STC approach is the development of a technological capability to sustain the competitive advantage of certain industries or locations. This is compatible with the TS's notion of competence development (either technological or economic) in a technological system. In addition to this, Molina and Kinder (2001) also point out that: '*Many of the elements of the NSI/cluster diamond are present in the constituencies' diamond of alignment.'* (Kinder and Molina, 2001) How they relate to each other is illustrated as follows:

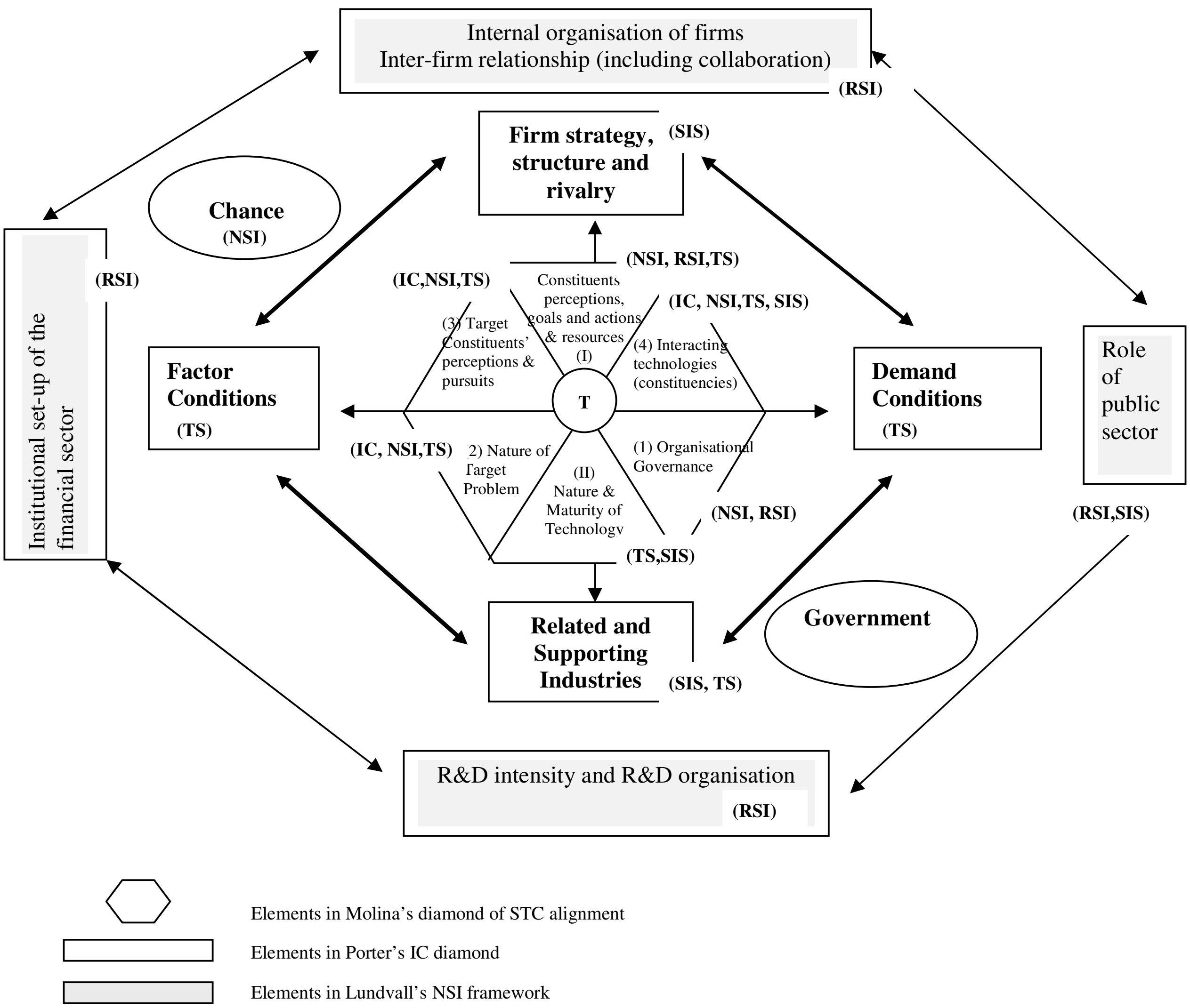
The alignment in segment (1), governance, relates to the 'role of public sector' as suggested by the NSI approach and the 'government' in the IC diamond. According to NSI theory, the governance processes are likely to differ due to different national histories and to legal and cultural differences. The governance dimension of the STC approach also highlights the impact of the industrial and market environment. This resembles the innovative milieu as proposed in the RSI approach, which provides informal governance in the form of 'collective orders' or 'microconstitutions'.

The alignment in segment (2), targets constituents' perceptions and pursuits represents the additional resources, including potential customers or financial resources that are needed to support the development of a constituency. This segment actually links to the implementation of Porter's 'firm strategy' at the company level or 'cluster strategy' at the regional or national level to actively and purposely seek additional people, organisation and resources (IC's factor conditions or NSI's financial sector) to enhance the growth of the sociotechnical constituency. It also resembles the TS approach which suggests that entrepreneurs have to seek complementary resources from the venture capitalist or to open up potential markets.

The alignment in segment (3), the nature of target problem, relates to the capability of the constituency to deliver successfully the intended results. In the case of a cluster as target problem, this dimension is related to the strength and weakness of the existing institutional set-up as suggested by the NSI and IC approaches and includes the internal organisation of firms, inter-firm relations, the financial sector etc. as they actually condition the initial stage of development and growth potential of the clusters. (Molina and Kinder, 2001) The competence embodied in different institutions, as suggested by the TS approach, also affects whether or not the 'target problem' can be tackled effectively.

Finally, the alignment in segment (4), interacting technology, is connected to the IC's approach of 'firm's rivalry' and the NSI's approach of 'user-producer relationship'. Cooperation enables firms to acquire complementary knowledge resources and competence, as suggested by the NSI, RSI and TS approaches. However, competition may also drive firms to innovate, as the IC approach points out. The SIS and TS approaches also highlight the importance of selection and competition in the market, as they are the keys to the creative destruction process. Figure 2.2 illustrates the relationship between the elements of Porter's IC diamond, Lundvall's NSI elements and Molina's diamond of STC alignment. The author of this thesis has added some relevant or correlated viewpoints highlighted by other cluster approaches (including RSI, SIS, and TS) to the figure to illustrate their relationship graphically.

Figure 2.2 Graphical illustration of the relations among six cluster approaches (building on Molina and Kinder's (2001) integrated framework of NSI, IC and STC)




## 2.4 Justifications for the chosen theoretical framework

As already stated, this thesis has chosen Molina's STC approach as the theoretical framework for the 'processual' analysis of cluster-building ('meso' level) and project-building ('micro' level) in the empirical case studies in later chapters. The NSI/IC approach is used for the analysis of the regional industrial context ('macro' level). Apart from the advantage of this approach in that it integrates many of the insights from other cluster approaches, the STC approach is also privileged over other approaches (especially the IC and NSI approaches) for the following reasons:

**1. Combining technology and social perspectives**

In some cluster approaches, such as in the NSI, RSI and SIS, technological development is taken for granted. This implies that economic actors are mainly responsive to technological change. The IC and TS approaches highlight the important roles of actors in leading to the emergence and development of new technology. The STC approach combines these two perspectives in an understanding of how technology and social processes are related. Influenced by the concept of the 'social shaping of technology', Molina (1993) recognises that technological change is defined by actors, while actors' actions are conditioned by the nature of technology and the economic structure. On the one hand, technological change depends on the technological potential, market opportunities, institutions and the structure of the economy, while on the other hand, these factors are all affected by the human actions, social relations and the specific organisation competence. In short, the STC approach has taken into account the combined forces of technological uncertainty, structural limitations and the free will of human action in its attempt to study the process of technological change.

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**2. Bridging the division between actors and structures**

Porter's (1990) IC approach emphasises the strategy an individual firm chooses to compete in the market environment, while Lundvall's (1992) NSI and Cooke et al.'s (1997) RSI approaches emphasise the structures which influence the innovation of a firm. These different approaches create a dichotomy between an innovative agent and the innovative environment. However, Mowery and Nelson (1999) argue in the conclusion of their book that: '*to a considerable extent, the sources of industrial leadership reside in structures intermediate between nations and firms.'* (Mowery and Nelson, 1999, p. 368) Sharing a similar view, the concept of the STC approach also places a particular emphasis upon the 'meso-level' of interaction between the economic actors and their environment (Williams and Edge, 1996), thus bridging the division between the actors and structures. Molina stresses that every action happens in a given structured environment, while at the same time social action has an effect on the structure, either in changing it or in developing a new one. He argues that structures and actors are in an interactive relationship and mutually shape each other.

**3. Emphasis on the purposiveness of actions**

With the influence of evolutionary economics theory, the innovation system approach (incl. NSI, RSI and SIS) tends to depict firms mainly acting in accordance with their routines in response to the external environment. Although it is true to a certain extent that much of the firms' activities are routinised, the innovation system approach has difficulty in explaining how novel technology and entrepreneurial activity come about, as there is not much room for goal-directed behaviour to take place beyond this response mechanism. As McKelvey (1991) points out, the innovation system approach is suitable for explaining performance and outcomes, rather than intentions and purposes. In contrast to the innovation system approach, the STC approach seeks to understand the 'purposiveness' of human actions through analysing the individual actors and organisations' vision, perception and pursuits. The cluster building process is conceptualised as 'purposive problem solving activities' in the STC approach. Kinder (2003) also suggests that the STC approach is more suitable for analysing an innovation process where a particular outcome is privileged, including the goal-directed cluster building process.

## 2.5 Some key concepts of the chosen theoretical framework

Appendix 1 outlines the major conceptual issues behind this research and here is a summary of theories and concepts that are key to the study of the cluster building process. Since these concepts are found scattered in a wide range of disciplines, this section attempts to give a systematic view focused on three major dimensions of the nature of a cluster, namely, the knowledge, geography and network dimensions.

### 2.5.1 The knowledge dimension of a cluster

**Technological change as an interactive social process**

Theories concerning technological paradigms (Dosi, 1982) have been criticised by some scholars for exhibiting 'technological determinism'. They argue that social factors also play a role in technological change. (Winner, 1999; MacKenzie 1996, 1999) In short, technological change can be regarded as an interactive social process which involves complex social activities and interactions among various technological and economic factors and different social actors and institutions.

### Co-evolution of technology and industrial structure

There are a number of studies concerned with the co-evolution of technology and industrial structure. (Schumpeter, 1950; Nelson and Winter, 1974; Utterback and Abernathy, 1975) In the early stage, the technology being developed is highly diversified and unstable, and the industry mainly consists of a number of small firms with a lot of entries and exits. As the technology improves and the market grows, the number of firms in the industry also increases. However, when a dominant design emerges and specialised production processes develop, the entry barrier begins to rise because of the increasing production scale and capital requirement. Also, incumbent firms have advantages relatively to the new entrants due to the cumulative nature of the learning process. (Dosi and Nelson, 1994) Finally, after the natural selection, the industrial structure settles down to a collection of established large firms.

### Rise of the information communication technology paradigm

Freeman (1987a) describes the phenomenon of the increased importance and use of information and communication technology (ICT) as ‘the rise of the information-technology paradigm’. This technological revolution provides the necessary infrastructure for the formation of the knowledge-based economy. It enables firms to integrate their production processes in various locations, at the same time as maintaining their organisational flexibility.

### Knowledge and learning

Knowledge is the most crucial input to innovation, specially the technological knowledge used by firms in the course of R&D. Polanyi (1966) categories such knowledge into codified and tacit knowledge. Technology-push and demand-pull are the two basic approaches to explain the process through which knowledge is translated into a new technology product. Yet, Schmookler (1966) acknowledges that innovation is generally a coupling activity between technical knowledge and market opportunity. Walsh (1984)’s research also shows that the relative importance of technology push and demand pull varies with time and the maturity of the industrial sector.

Various kinds of knowledge constitute the knowledge base of a firm. Rothwell (1977)’s research shows that about two thirds of the knowledge used by firms for innovation is derived from internal sources, particularly from R&D, while the remaining one third comes from learning from external sources including users, suppliers, competitors, universities and government bodies, etc. Lundvall and Johnson (1994) point out that technological knowledge is brought into innovation through the learning processes in a firm. Child and Faulkner's (1998) concept of organisational learning refers to the capability of an organisation to acquire, disseminate, and retain new knowledge so as to improve its future performance. Nelson (1982) and Rosenberg (1990) argue for the importance of firms conducting R&D, since this helps them search and learn more efficiently.

**Role of government**

The traditional justification of public support for technology and innovation comes from the market failure approach. However, Nelson (1982) argues that the main stimulus for technology policies nowadays comes from the perceived 'best practice' in a world system of international competition. The evolutionary economic perspective identifies two important processes in these policies; first, to stimulate innovation (variety) and second, to facilitate diffusion (selection) (Metcalfe, 1994). Fleck (1988) argues that the processes of innovation and diffusion are mutually supportive, as reflected in the phenomenon of 'learning through diffusion' and 'diffusion through learning'. Metcalfe (1994) adds that it is important for policy makers to see innovation and diffusion as inseparable when designing technology policies.

Edquist (1997) uses the term 'innovation system' to describe the systemic interaction among various elements and institutions in society underpinning innovation activities. In an innovation system, the government has a number of important roles to play, including 1) to act as an interface between different institutions and foster the creation of linkages among different institutions; 2) to provide strategic direction for technology policies; 3) to provide tradition and technological infrastructures, such as education and training, basic research and science parks, etc., and 4) to institutionalise technology policies and to enforce its actual implementation.

### 2.5.2 The geographical dimension of a cluster

The focus on the geographical dimension of a cluster was triggered by the recognition that a great deal of innovative activity appeared to be taking place in the form of local or regional agglomerations. Over the years, a number of scholars have sought explanation for this phenomenon of regionalised pattern of innovation activities. Among them were those from the disciplines of economics and geography.

**Location theory and new trade theory**

The economic significance of spatiality has been explained by a number of location theorists. Marshall (1890) identified three distinct reasons for localisation. By concentrating a number of firms of the same industry in one place, an industrial centre allows a pooled market for workers with specialised skills, provides non-traded inputs specific to an industry in greater variety and at lower costs; and generates technological spillovers as information flows locally more easily than over great distances.

During the last decade, a 'new' trade theory has emerged which emphasises that the geography of a nation has played a key role in determining the trade performance of a nation's industry. Krugman (1991), a key contributor to the new trade theory highlights the relationships between location and trade, the role of increasing returns and externalities in the localisation of industry and the significance of history which leads to the phenomenon of 'lock-in' and path dependence with regard to regional development. Besides, there has been a great deal of evidence suggesting that an increased concentration of a particular industry within a specific geographical region promotes knowledge spillovers across the location production system. Glaeser et al. (1992) point out that the costs of communication and transactions are minimised, thus resulting in a higher probability of knowledge spillovers across individuals within the population. Patel and Pavitt (1994) also add that owing to the tactic nature of the knowledge for innovation, especially in its early stage of development, it is best transmitted through personal interaction within geographic proximity.

**New economic geography and learning**

Different from the Marshallian notion of localisation which emphasised co-location for cost saving and external economies, the new economic geography which emerged in the 1980s offers explanations to the agglomeration phenomenon based on the innovation and learning processes in cities and regions. Scott (1998) points out that firms will locate in close proximity to one another in a geographical space due to high transaction costs. Such tendency to agglomerate will be further reinforced by the development of common skills and aptitudes of the workers who reside around the local production system. Storper (1995) adds that firms locating within a cluster of related firms can reap the benefits of 'untraded interdependencies'. Since 'untraded interdependencies' provide a common code of communication and a set of rules to govern firms' behaviour, learning and innovation in a region can be facilitated. Camagni (1991) uses the term 'innovative milieu' to describe a region with relations characterised by 'untraded interdependencies', through which the collective learning process can be facilitated and the local innovative capability can be enhanced.

Florida (1995) describes the function of learning regions which act as collectors and repositories of knowledge and ideas by providing an underlying environment or infrastructure to facilitated the flow of knowledge and learning. Amin and Thrift (1996) add that the 'institutional thickness' of a region which has a strong presence of institutions demonstrating high level of interaction and awareness among each other can contribute to the generation of trust and development of collective learning. Saxenian (1994) argues that the success of Silicon Valley over Boston 128 was attributed to the culture of greater interdependence and exchange among individuals in the region.

### 2.5.3 The network dimension of a cluster

The research evidence shows that networks have played a major role in promoting regionalised patterns of innovation activity. The governance perspective sees networks as a hybrid choice between 'market' and 'hierarchical' relationships (Williamson, 1979) and it helps reduce transaction costs and achieve governance in an organisation structure. The competence perspective emphasises the importance of networks in improving competitive strength (Porter, 1980) and as a means to obtain external knowledge and complementary resources from other organisations through learning. (Preece, 1999) The social construction perspective pays special attention to the social nature of networks. Hughes (1983) proposes to us a 'system' approach to understand the evolutionary process of networks and highlights the role of system builders in the creation of a network. Pinch and Bijker (1984) point out the problematic nature of network building since it involves ‘reciprocal relationship between artefacts and social groups’. Nooteboom (1999a), however, points out that trust can play a crucial role in stabilising a network by removing the fear of opportunism and enabling direct communication when problems arise.

**Network building process**

According to Nooteboom (1999a), one of the ways to overcomes behavioural and environmental uncertainties is by building trust through the development of a network. The network building processes can be summarised into the following steps:

1. Identification

When selecting a partner, one has to search explicitly for partners with similar values and motives as commonalities will facilitate the building of trust. (Deutsch, 1973) A typical way of understanding a partner’s characteristics is by reviewing its track record. (Ebers, 1997) Also, an emphasis on a long-term relationship is essential to the development of trust because it declares that the relationship itself is considered valuable.

2. Familiarisation

Trust requires familiarity and mutual understanding and depends on repeated interactions between partners. (Beger and Luckmann, 1996; Zucker, 1986) A relationship between strangers tends to start tentatively, with small steps that do not demand detailed contracts. More trust will be generated through the emergence of relation-specific norms and values, empathy and friendship. Intermediaries, such as trade associations, ‘hub’ firms, universities and public agencies are the key catalysts and can provide coordination for the interaction between partners. (Sydow, 1996; Nooteboom, 1998, Huggins, 2000; Lipparini and Lomi, 1999)

3. Institutionalisation and habitualisation

Appropriate rules of the game will be developed through repeated interactions between partners and this will lead to the institutionalisation and habitualisation of the networks. Studies demonstrate that the institutionalisation of network coordination mechanisms into documents and contracts can enhance transparency and reinforce procedural justice in inter-firm relations (Greenberg, 1990) and facilitate the diffusion of the practice and its flexible application in the new contexts. (Heylighen, 1999) Besides, informal governance based on norms, values and habits of conduct will also help curb opportunistic behaviour and reinforce the formal governance practice through the generation of trust. (Scher, 1999)

**The diversity of public and private linkages**

In recent decades, there have been some major changes in the patterns of collaboration in innovative networks. In quantitative terms, there is a strong upsurge of various forms of research collaboration, including extensive international collaboration as well as national and regional networks in new generic technologies. In qualitative terms, there are changes in the nature of networking relationships. Apart from sub-contracting networks, many new forms of collaboration have appeared, such as research associations, government R&D projects and programmes, R&D consortia, etc. While Hagedoorn and Schakenraad (1990) argue that the upsurge of new networking arrangements is a transitory phenomenon of adaptation to the diffusion of new generic technologies, others view that networking between firms will grow and will become the normal way of conducting product and processes development.

Nelson (1988) points out that universities are responsible for radical innovation and industry supplies the incremental improvements, so that the relationship between the two communities has been strongly complementary. Schimank (1988) adds that there is evidence of intensification of technology transfer activities between university and industry due to the 'simultaneous transfer motivation' of both actors. However, Faulkner's and Senker's (1994) study highlight that the predominant role of public sector research (PSR) in innovation still lies in the training of qualified scientists and engineers and giving help to companies in the areas of experimental procedures and instrumentalities. Schimank (1988)'s research highlights the role of government as a catalyst for the increasing university and industry collaborations.

## 2.6 Chapter summary

While the theoretical approaches regarding the study of clusters are numerous, this section has chosen six main approaches to shed light on them. They are national systems of innovation, regional systems of innovation, sectoral innovation systems, industrial clusters, technological systems and sociotechnical constituencies. The aims of this chapter have been to enhance the understanding of clusters through critically compare the cluster theories with each other and to select an appropriate approach to be the theoretical framework of this thesis to study the ICT-cluster building process in Scotland and Hong Kong.

In fact, the six cluster approaches presented above do not perfectly answer all the questions in relation to the cluster building process. The strengths of these six cluster approaches tend to be in identifying a range of elements which make up a cluster, while leaving the cluster building process untouched in the theory. The key problem in the above six theories is that they provide little understanding of the process involved in the formation of a sustainable cluster. For example, what kind of processes are involved and how can these processes be made operational for strategy and policy purposes, so that we can create a cluster purposively? Although the STC approach is more privileged than other cluster approaches in explaining the cluster building processes and has answered some of the questions, the approach still leaves some theoretical gaps unaddressed. For instance, the STC approach is vague in giving a clear or adequate explanation as to how to unfold the mechanism involved in the cluster building processes. Therefore, it demands an empirical research to put the STC's theoretical explanation to test in a real life context and to further research the cluster building processes.

The final section of this chapter summarised some of the key the concepts to the study of clusters. The social studies of technology point out the complex relations between technical and social elements. Evolutionary economics highlights the co-evolution between technology and industrial structure at various stages. These insights are of particular importance to the understanding of the constituents of an ICT cluster and the context in which a cluster develops. Besides, the discussion also deals with the theories related to the three dimensions of clusters, namely the knowledge, geography and network dimensions. The knowledge dimension stresses the importance of knowledge creation and learning in the course of innovation, as well as the crucial role of government in the development of appropriate innovation systems to facilitate these processes. The geographical dimension highlights that various agglomeration benefits such as increasing return due to economic externalities, lower transaction costs, innovative milieu and learning regions are important to attract companies to co-locate in a certain geographical space. The presence of these factors also represents a condition for the cluster building process to take place. The network dimension of a cluster explains the motives and benefits to enter into a network, as well as its problematic nature. Finally, concepts like 'identification', 'familiarisation' and ‘institutionalisation/habitualisation’ help us understand the emergence and evolution of a cluster constituted by multiple public and private networks.

The literature reviewed above implies that when studying complex cluster-building processes, it is necessary to take into account the concepts and dimensions of clusters just presented. This means that we need to design a research methodology capable of capturing the context in which the clustering process begins (geographical dimension), the networking process among the major actors (network dimensions and network building process), as well as the knowledge flows and learning processes among them, along the cluster development (the knowledge dimension and evolution process). The following chapter describes an original research design that seeks to integrate these elements and at the same time avoid some of the weaknesses of the previous research done by other cluster researchers.

# Chapter 3 Research Design and Methods

**Objective: to describe the methodology for collecting data to answer the research questions**



## 3. Introduction

Below is a recapitulation of the major and subsidiary research questions of this thesis, as outlined in section 1.2 of chapter 1. The key research problem is: '**How can an industrial cluster be built by policy design and what are the processes involved in cluster building**?' The four subsidiary research questions in relation to the cluster building process are:

1. What is the nature of the processes involved in the purposive attempts to create clusters?
2. How are clusters' visions, strategies and policies created and implemented?
3. What factors and difficulties influence or affect the translation of cluster visions and strategies into practice?
4. Can general good practice be identified for policy processes in different regions or countries?

Given the reasons explained in Chapter 2, this thesis chooses to adopt Molina's (1990, 1993, 1999) STC approach as the theoretical framework to study the cluster building processes in the two regions. With reference to this framework, an original research has been designed to collect data in Scotland and Hong Kong. In this chapter, a detailed account of the research design and the specific data collection methods are given. The structure of this chapter is as follows: Section 3.1 explains the research design and the rationales behind it, followed by an introduction of the instrument for collecting data in this research—the semi-structured interview. The key variables used as points of reference in the interview guide are also outlined. Section 3.2 describes the actual implementation of the research, including from whom and where the data is collected. Finally a chapter summary is given in section 3.3. In addition, an account of the retroductive research strategy adopted in this research and the limitations of this research, including the theoretical concerns of the chosen methodology and some ethical issues can be found in Appendix 3.

### 3.1 Research Design and Methods

The design of the research for this thesis aims at collecting data to answer the main research questions and basically incorporates five elements. They are:

1. Mapping of the ICT clusters in Scotland and Hong Kong.
2. Context analysis of the two clusters—the wider economic environment and industrial structure of Scotland and Hong Kong and their relation to the two ICT clusters.
3. Detailed longitudinal analysis of the 10-year cluster building processes in Scotland and Hong Kong
4. Auditing the nature, success, failure (including the strengths of the cluster networks) and obstacles of the cluster building processes in Scotland and Hong Kong.
5. Integrating the insights from above to an understanding of the cluster building process in Scotland and Hong Kong, with the aim of identifying good practice in cluster building.

The justifications for the above research design are given in the next in section 3.1.1. As mentioned in chapter 1, the data collection of this research is based on a case study method. The justifications for adopting this method have been listed in section 1.4. The instrument for collecting primary data is semi-structured interviews. Section 3.1.2 gives a brief account of the justifications for carrying out semi-structured interviews in this research and the key variables used in the interview guide as indicators for the cluster building process.

### 3.1.1 Justifications for the research design

Much of the empirical research on clusters has been criticised for being ad hoc[2]. This implies that many of these studies are either not grounded theoretically or lack clear evidence of the clustering process involved. As Martin and Sunley (2003) point out, this problem is largely due to '*no agreed method for identifying and mapping clusters, either in terms of the key variables that should be measured or the procedures by which the geographical boundaries of clusters should be determined*.' (Martin and Sunley, 2003, p. 19) In Table 3.1, Swann (2002) shows the diversity of cluster concepts and the corresponding difficulties of measuring them in empirical studies. The research design outlined in this thesis has taken into account the issues raised below, and hopes to contribute to an improvement of the current state of affairs as much as possible.

Table 3.1 Variables of cluster and the cluster measurement problem (Swann, 2002 in Martin and Sunley, 2003, p. 20)

| Cluster concept | Conceptual/ definitional depth | Empirical methodology | Ease of measurement | Empirical support |
|---|---|---|---|---|
| **Co-location** | Shallow | Top-down | Easy to measure (quantitative) | Indirect evidence |
| **Co-location and technological proximity** | ↓ | ↓ | ↓ | ↓ |
| **Input-output table complementarities** | | | | |
| **Co-location and superior performance** | | | | |
| **Marshallian externalities** | | | | |
| **Network firms** | | | | |
| **Explicit collaboration** | | | | |
| **Informal knowledge spillover** | Deep | Bottom-up | Hard to measure (qualitative) | Direct evidence |

### 1. Mapping of clusters

As the table above shows, the empirical study of clusters necessitates a 'mapping' strategy to identify the 'real' clusters. However, such strategy varies considerably, as clusters can either be

[2] For instance, DRI/McGraw-Hill (1995)'s research identified that there are no less than 380 clusters in the US. The author of this thesis does not believe this is a fair observation, the implication being that some of his identification of clusters may be termed as 'ad hoc'.

identified from top-down, such as by use of national industrial statistical data to indicate localisation of specialised activity or linked activities, or from bottom up, to identify clusters in particular regions or local areas. As Martin and Sunley (2003) point out, either strategy has its own drawbacks. A top-down mapping provides a shallow view of the inter-firm linkages (traded or untraded), knowledge spillovers, social networks, etc, while the bottom- up mapping may lead to an association of the identification of clusters to local/regional governments' definitions or aspirations.

The research of this thesis seeks to combines these two mapping strategies. Thus, the evidence of localisation and specialisation of the ICT industries in the two regions is shown in the economic statistical data, and their economic significance to the two regions is reflected in the export and employment figures.  Also, these two ICT clusters are explicitly recognised by the two regional governments, with identifiable public support institutional structures and openly acknowledged key cluster players.  In addition to the above, the decision of researching ICT clusters in Scotland and Hong Kong is also supported by proponents of the regional systems of innovation approach (Cooke, et al., 1997), who admit that the boundary of a national innovation system is too broad (especially in view of the resource constraints of being a lone researcher in this project) and who stress the importance of the geographically related innovative milieu.

**2. Contextual analysis (initial conditions)**

As a starting step in integrating the cluster theory to empirical work, a contextual analysis of the 'macro' regional industrial/sectoral levels in Scotland and Hong Kong is carried out.  This makes use of the integrated IC and NSI frameworks, and to the extent that it analyses the ICT industry, it simultaneously makes an analysis of the initial conditions for the ICT cluster-building processes ('meso' level) in the two regions. Indeed, as Molina and Kinder (2001) point out, the contexts, manifested in terms of factor conditions and institutional set up, set the initial conditions and content for the clusters to emerge and that a weak 'context' may constrain the further development of a cluster to become sustainable or competitive. As shown in the literature review in Appendix 1, technological change depends on the technological opportunities, market potentials, R&D institutions and the structure of the economy as a whole. Therefore, the contextual analysis covers all these elements, with the aim of showing how these 'contextual/initial elements' condition the emergence of clusters within the regions. In particular, this contextual analysis includes a detailed examination of the institutional structure within which the actors of the clusters act. This is regarded as a necessary step as technology, regardless of the fact that its form may be artefact, knowledge or competence, is embedded in institutions (Lundvall, 1992; Carlsson and Stankiewicz, 2000). These institutions are on the one hand affected by the wider economic environment of the region/nation, while, on the other hand, they themselves affect the perception and actions of the actors, (Scharpf, 1995; Molina, 1993) as they provide a context for their interactions.

**3. Identification of cluster building activities**

The identification of cluster building activities is a problematic area in many cluster studies. Many cluster studies tend to apply a 'snap shot' focus on a cluster (i.e., to study a cluster at a specific time), but it is unlikely to capture the long term cluster building process. This thesis applies a longitudinal approach to shed light on the 10 year cluster building processes in Scotland and Hong Kong. By conducting content analysis on various archive materials obtained from newspapers, government documents, statistical data, etc., the key incidents and events that took place along the cluster building process can be identified. These key events not only help define the different phases of the cluster development, but also show evidence about the changes and development of a cluster over time. Besides, through a detailed longitudinal study, the specific steps for building clusters can be mapped out and this helps draw implications for other policy makers who may seek to learn from the cluster building experiences of Scotland and Hong Kong.

**4. Audit of cluster building activities**

This thesis applies Molina (1990, 1993, 1999)'s diamond of sociotechnical alignment as a theoretical tool to assess the success and failure of the clusters in Scotland and Hong Kong at their different phases of development. This method is useful for identifying the mis-alignments/problems which may affect the continual development of the respective clusters in the future. Besides, at the end of the 10 year period, this research goes deeper to evaluate the success and failure of the generation of cluster dynamics. The overall level of success of the cluster building process is evaluated in five aspects of 1) origin of the cluster, 2) make-up of the cluster 3) strategy of the cluster 4) governance of the cluster and 5) appraisal of the cluster. The data for this two-level cluster evaluations are obtained by semi-structural interviews, through which, some social aspects of the cluster building process, such as the major actors' different goals and motivations, as well as their perception towards the level of success or failure of the cluster, can be understood.

**5. Cross-country comparative analysis**

Finally, the findings of the ICT clusters in Scotland and Hong Kong are compared with each other. The objectives for carrying out a comparative analysis are twofold: 1) to enhance the understanding and to seek explanations for the cluster building process by looking at other clusters as a reference point. (This is similar to the function of a benchmarking exercise in policy research), 2) to identify the common mechanisms that underlie the cluster building process and the good practice/s required to build a cluster.

The justifications for choosing the ICT clusters in Scotland and Hong Kong as case studies have been given in section 1.3.3 of chapter 1. In addition, these two cases can also help eliminate two methodological problems which may occur in comparative analysis, namely the problem of focus and level of analysis (too many variables), and the problem of equivalence (incommensurability of concepts) (Bynner and Cbisbolm, 1998) As regards the first problem, it can be resolved by adopting a comparative case study approach, so that the trade-off between a large number of variables can be taken into account and a greater depth of case analysis can be achieved. The second problem can be addressed naturally. As Hong Kong was under British rule for 100 years, the background concepts referred to in this research can be understood by the actors in the two regions. On the whole, the comparative analysis also represents a triangulation method to enhance the validity of the research findings through replication.

### 3.2.2 The semi-structured interview and its key variables

**The semi-structured interview**

Punch (1998) points out that an interview is the most powerful way to understand others as it enables us to access people's perceptions, meanings, definitions of situations and constructions of the reality. This research chooses to apply semi-structured interviews as the major data collection instrument. This is for three reasons: First, it is useful for investigative or exploratory studies, especially when it involves an investigation of particular processes or events in historical or case study analyses. Second, it is useful when the literature or public information about the organisation or company is not available. For instance, the information on innovation processes or networking activities among firms is not always documented and cannot be obtained unless one asks the organisation. Also, when studying these activities, questionnaire surveys and structured interviews may not be applicable as it is not very clear which ‘variables’ are important and should be put to test. Third, a semi-structured interview is more suitable than an unstructured one. As clustering is a complicated phenomenon, a fully open interview may yield a large amount of data which is irrelevant or unimportant to the understanding of the cluster building process.

**The semi-structured interview guide**

As already stated, the interview guide is prepared for five main types of organisations, namely, ICT companies, universities and research institutes (especially the technology transfer and commercialisation agencies), government bodies, funding bodies and networking organisations, as they are regarded as the key actors of the clusters. Each interview guide is customised to meet the knowledge field of the organisation that the interviewee comes from. Each interview guide is divided into three parts. These are: 1) the context or background information about the organisation 2) the organisation’s involvement in the cluster and 3) the organisation’s specific linkages with other major players in the cluster.

The customised interview guides are attached in Appendix 9. The key variables used in the interview questions are underlined. A brief summary of these variables is outlined in Table 3.2. The chosen variables are grounded in the theoretical insights from the major cluster approaches outlined in chapter 2, in particular, Molina’s (1993, 1999) STC approach and its related STC alignment framework are of great use.

Table 3.2 Key themes and the examples of indicators used in the interview guide[3]

| *Key Themes* | *Examples of variables* |
|---|---|
| **Part 1 Context** | |
| Background information of organisation | • Organisational information<br>• Technology strategy |
| **Part 2 Involvement in the cluster** | |

[3] The author of this thesis is very grateful to Dr. Wendy Faulkner’s inspiration and assistance in identifying the key variables used in this interview guide.

| | |
|---|---|
| 1. Origins of clusters<br>(esp. motivation, vision and action) | • Vision<br>• Prime movers<br>• Motivation<br>• Resources: needed and available<br>• Action: incl. alliance and persuasion |
| 2. Make-up of clusters<br>(perception of what they and other members bring to the cluster, incl. resources, strengths and weaknesses, complementary aspects) | • Technology<br>• Different actors<br>-individuals & institutions<br>-expertise and other resources<br>-core and networks |
| 3. Strategy of clusters<br>(perception of what is required to build the cluster and make it work) | • Targets: aims and objectives<br>• Means of getting there<br>-access to resources<br>-alliance building for support<br>-technological collaboration<br>-other aspects of development and commercialisation of technology<br>-strengthening clusters and maximising their benefits |
| 4. Governance of clusters<br>(perception of how things actually happen, incl. power of major shaping actors) | • Governance: formal or informal<br>• Specific relationships<br>-individuals,<br>-other government<br>-overseas clusters |
| 5. Appraisal of clusters<br>(perception of any weaknesses or problems) | • Success and failure<br>-increasing resources<br>-increasing alliances<br>-strengthening governance<br>-strengthening technological capabilities<br>-depth of knowledge relation<br>• Problems |
| **Part 3 Specific linkages with other players within the wider network/cluster**<br>• look at the strategic aims the actors may have<br>• reflection on company-company linkages and both company strategy and cluster strategy | |
| 1. ICT companies (supply chain, competitors) | • Nature of links and role<br>• Any agglomeration benefits<br>• Any barriers to synergies |

| | |
|---|---|
| | • Any knowledge sharing or technology transfer |
| 2. Universities and government research institutes | • Nature of links and role<br>• Any agglomeration benefits<br>• Any barriers to synergies<br>• Any knowledge sharing or technology transfer |
| 3. Financial organisations | • Nature of links and role<br>• Any agglomeration benefits<br>• Any barriers to synergies<br>• Any knowledge sharing or technology transfer |
| 4. Government bodies | • Nature of links and role<br>• Any agglomeration benefits<br>• Any barriers to synergies<br>• Any knowledge sharing or technology transfer |
| 5. Networking organisations | • Nature of links and role<br>• Any agglomeration benefits<br>• Any barriers to synergies<br>• Any knowledge sharing or technology transfer |

## 3.3 The Collection of data

**Locating the subjects and lists of interviewees**

The interviewees of this research are located in Scotland and Hong Kong, respectively and have been carefully chosen. The selection of interviewees also reflects a combination of top-down and bottom-up approaches. Firstly, the government official websites for the respective ICT clusters offer a very good starting point.

- The Scottish ICT cluster's official website is: http://www.microelectronics.org.uk
- The Hong Kong ICT cluster's official website is: http://www.hksciencepark.com

These two official websites provide a lot of useful information regarding the study of clusters, including historical background, major cluster supporting programmes, funding opportunities and a large number of archives and news on future events. In particular, as part of their promotion strategies, these two websites contain a detailed industry/tenant directory. The companies/organisations listed in the directory are identified by the government as the participants of the clusters. Full details of these companies, including names and a description of business and contact details can be found in the directory. Apart from the ICT companies, the website also provides information and web links to other related actors such as the universities and public research organisations, venture capital companies and network supporting organisations, etc. By use of a random sampling method, about 100 companies/organisations have been chosen from the directory of each country as being potential interviewees of the respective ICT clusters. Secondly, to complement the top-down approach, the researcher also uses the ‘snowballing’ method to find the players who may have been overlooked by the government. This is done by asking the interviewees whom they recommend the researcher should talk to. This method has proved useful. For instance, an interviewee introduced a university spin-out company which actually plays an active part in the ICT cluster, but whose name is not on the industry directory as it is not located inside the ‘science park’.

The interviews were divided into two stages. The first stage took place from June to October, 2002 in Hong Kong, when 30 interviews were conducted with a wide range of organisations, including 14 ICT companies, 2 government bodies, 7 universities and research institutes, 5 funding bodies, 1 networking organisation and 1 consultant[4]. The second stage took place from December to April, 2002-2003 in Scotland (mostly in the Central Belt) when 30 interviews were conducted with 12 ICT companies, 5 government bodies, 5 universities and public research organisations, 3 funding bodies, 4 networking organisations and 1 consultant. Each interview was conducted with one or two senior managers of the organisations, preferably with the Technical Manager or Technology Director. The specific date and place of the interviews are listed in Appendix 3.

In short, the choice of interviewees represents a diversity of companies and of their organisational nature and structure. For instance, the selection of ICT companies covers a range of different origins and size (MNCs, SMEs and local start-ups) and different activities along the value chain (design, manufacturing, product/software development, sales and marketing). Therefore, the

[4] The decision to include a consultant as a major cluster player is based on Jasanoff’s (1990) argument that experts play an increasingly important role in public decision making in relation to science and technology developments, even though they are not necessarily constructing the process.

organisations that participated in the interviews can be said to represent the 'breadth' of the clusters, thus ensuring an acceptable level of confidence in the findings.

### 3.3 Chapter summary

This chapter introduced the research design and the research method of this thesis. The design of this research has taken into account the nature of the research questions and the theoretical underpinning of the chosen frameworks. It identifies five elements: 1). Mapping of clusters; 2). Contextual analysis; 3). Identification of cluster building activities; 4). Audit of cluster building activities; and 5) Cross country comparative analysis (Scotland vs Hong Kong). The research method applied is a combination of extensive archive analysis which covers over 10 years of the cluster development in the two regions, with 60 semi-structured interviews with 5 group of major actors of the two clusters, including ICT companies, universities, government bodies, financial institutions and networking organisations. A systemic account of the research and data analysis procedures, together with some reflections on the limitation of this research can be found in Appendix 3. A thorough discussion on these aspects help increase our confidence on the validity and reliability of the research findings.

# Chapter 4: Data Analysis-ICT cluster in Scotland

**Objective: to present the research results in the STC framework and analyse them for the relevance to the research questions**



## 4. Introduction

This Chapter 4 and the next Chapter 5 illustrate the stories of the Scottish and Hong Kong governments' efforts in trying to enhance their regions' competitiveness by seeking to advance towards knowledge economies through the development of high-tech industrial strategies. The two regions have embarked on cluster strategies based on different public policies to nurture and support the development of the ICT industries.[5] Their targets are to

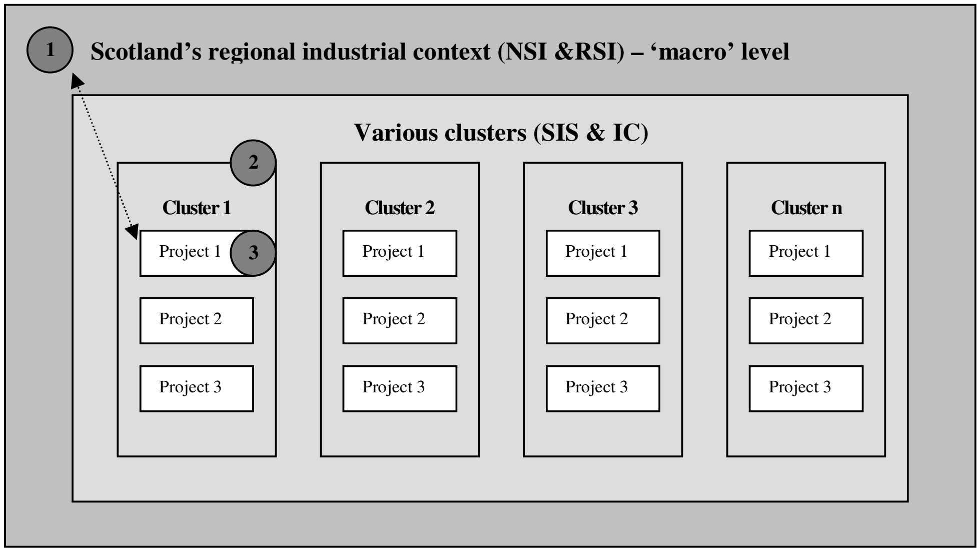
[5] As mentioned in Chapter 1, section 1.3.1, this thesis adopts a broad definition of ICT, covering the technologies applied on/to electronic components (hardware and software), consumer electronics, telecommunication equipments, computers, audio-video products, photographic and optical equipments. However, the provision of ICT services, such as e-commerce, mobile, internet or other communication service providers are not included.

upgrade their ICT industries from manufacturing to high value added product design and development through enhancing innovative content. It is believed that by bringing together industry, university and government and other related organisations within a cluster strategy, synergy effects can be generated and innovation can be stimulated through their intensified interaction. Despite the potential benefits to Scotland and Hong Kong of having a successful cluster, the process of creating a cluster is far from straightforward. This Chapter 4 analyses in particular the ups and downs of the cluster building process ('meso' level) in Scotland, using the STC approach and concentrating almost exclusively on the longitudinal analysis of the attempt to build up a knowledge-based cluster by policy design. Appendices 4 and 5 accompany this chapter to provide the full three-level analysis. Thus, Appendix 4 addresses the 'macro' level of Scottish regional ICT industrial context by using the integrated IC/NSI framework. A Table summarising this analysis is included in the next section of this Chapter 4. In turn, Appendix 5 contains the analysis of the constituency building process of Project Alba, the flagship project of the Scottish ICT cluster. At each stage, the process of the Alba Project is assessed through the 'diamond of STC alignment', identifying strengths and difficulties or obstacles affecting its development.

Later on, Chapter 5 concentrates on the longitudinal analysis of the cluster building process ('meso' level) in Hong Kong, again using the STC approach to facilitate comparative analyses. Appendix 6 accompanies this particular chapter, addressing the 'macro' level of Hong Kong regional ICT industrial context. Unlike the Scottish case, no Appendix is provided addressing the 'micro' level of 'project' constituency-building for the case of Hong Kong. Thus, only a two-level analysis for Hong Kong is included in this thesis, although the research was done, focusing on the Hong Kong's flagship project, the Science Park.

The relationships among the three-layers of the ICT sociotechnical constituency are illustrated in Figure 4.1.

Figure 4.1 Simplified representation of the three-layered (regional, cluster and project levels) analysis of Scotland's ICT cluster-building process




The outlines of this Chapter 4 and Chapter 5 are as follows: The first section starts with a brief summary of the overall economic/industrial and technological environment of Scotland/Hong Kong (as said, the full accounts are found in Appendix 4 for Scotland and Appendix 6 for Hong Kong). This 'macro' regional level of analysis represents the general existing conditions for the ICT clustering processes in the two regions. They can also be seen as the base or starting conditions for the policy-driven clustering processes in the two regions. The major findings regarding these general existing conditions in Scotland/Hong Kong are analysed making use of the IC/NSI framework. The bulk of Chapters 4 and 5 concentrates on the longitudinal analysis of the constituency building processes of the ICT clusters in Scotland and Hong Kong ('meso' level). Owing to the length of the constituency building process, the analysis identifies four stages: namely, birth, growth, development and evolution of the ICT clusters, covering issues in relation to the origins, visions, strategies, governance and success and failure, and the re-alignment efforts of the Scottish/Hong Kong ICT cluster. At each stage, the constituency building process is assessed through the 'diamond of STC alignment', which reveals the state of alignment or harmony of the cluster-building process, identifying difficulties or obstacles affecting its development. Finally, Chapters 4 and 5 contain an assessment of the overall ICT cluster-building process in Scotland and Hong Kong respectively from their inception to their present state of development. The major lessons distilled from the experiences of Scotland/Hong Kong's cluster building processes, and their major future challenges are discussed.

## 4.1 Brief Summary of 'Macro' Level 1 - Regional layer (Industry/market level)

### 4.1.1 Brief background about Scotland

Scotland can be defined as a small economy with a population of 5,062,011 (Scottish Enterprise, 2004a) and GDP of £69,179 million in 2001. (Office for National Statistics, 2004) Historically, Scotland has been an important manufacturing base for many decades, however, nowadays, the service industry is the most important sector of Scotland, accounting for approximately 70% of the total employment and the value of output measured by gross value added (GVA). The manufacturing sector, on the other hand, only accounts for 23% of the employment and 28.4% of the GVA (Scottish Executive, 2003a; Scottish Executive, 2001a) The economic structure of Scotland is largely dominated by small and medium sized firms, 98% of the companies in Scotland have less than 50 employees. (Scottish Enterprise, 2003a)

Scotland's business R&D expenditure (BERD) only accounted for 0.6% of the GDP in 2001, which was less than the OECD average of 1.62%. (Scottish Executive, 2003c), although Scotland's higher education sector was relatively active in engaging in research and development and commercialisation activities. The number of patents granted to Scottish applicants accounted for only 3.8% of the UK total in 2001, due partly to the lower R&D spending in Scotland. (Patent Office, 2002)

The ICT industry has developed in Scotland for almost 50 years. The industry was firstly started by a number of US companies who were involved in the manufacturing of electronic equipments and semiconductors. Thanks to the government's generous financial inducement package from 1940s to mid 1980s, there were three waves of inward investments to Scotland, including companies from the Far East. However, the domination of inward investors also left the industry with a small indigenous sector and low technological capabilities since these inward investors tended to locate their R&D close to their headquarters outside Scotland and the ICT companies simply applied the technology developed elsewhere in their production processes.

The present ICT sector of Scotland consists of a number of sub-sectors including electronic and semiconductor manufacturing, microelectronic design, optoelectronics, software and e-commerce, and communication technologies. The largest subsector—electronics and semiconductors—employed over 45,000 people directly and other 29,000 people indirectly, representing 12% of Scotland's total manufacturing employment and 14% of the GDP in 2005. (Scottish Enterprise, 2005a) The newly emerged microelectronic design and optoelectronics sectors also employed 1,400 and 4,200 people in 2005, respectively. (Scottish Enterprise, 2005b; 2005c)

Yet, there are a number of structural impediments to the development of cluster in Scotland. Firstly, ICT companies in Scotland have poorly integrated local user and producer relations and the knowledge flow among them is limited, despite the companies tend to have closer relationships with their overseas customers. Secondly, the cluster development is constrained by the weak industry-university relationships. The main barriers to their collaborations are the discrepancies between the universities' and the industries' nature of research, time scale and culture. The relatively unsophisticated technological capabilities of the indigenous ICT firms, together with their small number and size also contribute to this problem.

Thirdly, the unavailability of early stage capital also leads to the under-performance of technology ventures in Scotland. On one hand, Scotland is hindered by its lack of entrepreneurial culture and slow commercialisation process. On the other hand, the reluctance of venture capitalists to invest in early stage technology companies and university spin-outs due to their lack of confidence has made the situation even worse. In spite of the government's recent effort to introduce a number of financial assistance programmes to help bridge the financial gap, the execution of these programmes are by no mean without flaws. Last but not least, the effort of developing a technology cluster in Scotland is hampered by the lack of cohesive and holistic planning from the government. Besides, there is insufficient motivation from the government whose supporting mechanisms are deemed as piecemeal by the public. This calls for a more strategic role from the government to lead and coordinate the cluster building efforts in order to stimulate the technology development, in particular because Scotland's competitive advantage in ICT has gradually eroded due to competition from emerging economies like Eastern Europe and China.

*A detailed discussion of the different aspects of Scotland's innovation system, namely the history of its ICT sector, the evaluation of the inter-firm relations, university-industry relationships, firms and financial sector's relationships and the involvement of Government in the development of the innovation system can be found in Appendix 4.*

### 4.1.2 Scotland's Regional ICT Industry/Sector in NSI/IC framework

Table 4.1 uses the combined IC/NSI framework to summarise the major characteristics of Scotland's ICT sector in terms of its strengths, weaknesses, barriers and opportunities. It represents the initial conditions for the development of the ICT cluster. The analysis is divided into two levels. 1) the general conditions of Scotland 2) the specific conditions of the ICT sector.

Table 4.1 Application of the NSI/IC framework to assess Scotland's ICT sector

| |
|---|
| **1. Factor conditions/institutional set up of financial sector**<br><br>**a. Scotland**<br>• Scotland is small economic region in terms of population and GDP. Its population possess the education levels and qualifications necessary for developing high technology industries<br>• Scotland has a well developed physical infrastructure (water and power supply) but transportation links and internet connections still need to be improved.<br>• Scotland is the second largest financial centre outside London. However, the financial sector does not engage locally and the lack of funds is one of the largest barriers to innovation.<br>• The government launched different initiatives to bridge the funding gaps for new companies, but their impact has been limited.<br><br>**b. ICT sector**<br>• The ICT industry is of major importance to Scotland's economy. It is the largest exporter of the region.<br>• As the traditional ICT manufacturing declined rapidly, the government pledged to support the development of high value added ICT design industries, including microelectronic design, optoelectronics and software development.<br>• Scotland's ICT sector is dominated by inward investment, while its indigenous sector is relatively small and new.<br>• There is a lack of raw materials and price advantages, while ICT companies mainly source components from overseas.<br>• There are a sufficient number of high quality workers for ICT manufacturing and design industries, but a lack of management personnel. |
| **2. Demand conditions/role of public sector**<br><br>**a. Scotland**<br>• Domestic market is small, most of the products made in Scotland are exported to Europe and |

US.

- Major early government industrial policies include the provision of Regional Development Grants and the development of 'new towns'.
- Devolution since 1999 offered opportunities for Scottish government to directly involve in regional economic and technology development.
- Scottish Government lacks the holistic strategy to support innovation and technology. Initiatives are piecemeal and not well communicated to the relevant parties.
- There is in general a lack of demand for technology from the universities, particularly from the SMEs.
- Early industrial policies tended to focus on attracting inward investment instead of upgrading technological capabilities.
- Government is perceived as lacking the commitment to pursue a long-term economic development strategy.

**b. ICT sector**

- Difficulties in manipulating or changing the demand conditions as the dominant majority of the ICT products are exported.
- Large ICT companies do not use local suppliers and do not have local customers. User-producer linkages are weak and there is limited knowledge exchange between them.
- Small ICT companies use a small number of local suppliers, but they tend to serve overseas' customers. The linkages are strongly oriented towards these customers and they have a high level of knowledge exchange.
- Scottish ICT companies mainly produce intermediate ICT products, while there is no large system company with headquarters function in Scotland.
- The public sector played a key role in the development of the early ICT sector, by becoming a main user of defence electronic products and adopting a 'sectoral approach' to attract foreign ICT companies to locate in Scotland.
- Government supports the development of new ICT sub-sectors through the provision of infrastructures, a regulatory regime and financial assistance for new start-up companies.

**3. Related and supporting industries/R&D intensity and R&D organisation**

**a. Scotland**

- Scotland's overall investment in R&D is relatively low (0.6% of the GDP) and below the UK level and OECD average.
- The region has a very strong research base at universities and research institutes, but companies seldom engage in basic and fundamental research.
- Most companies consider to a large extent, their customers, and to a lesser extend, suppliers, as

their source of innovation. None of them consider universities as a major source of innovation.

- The major barriers to innovation are the predominance of SMEs in Scotland (98%), as they lack the resources and personnel to conduct R&D.
- Other barriers to innovation are the lack of funding and the lack of technological capabilities within the ICT companies.

**b. ICT sector**

- Large ICT companies do not have R&D functions as they are mainly branch plants of major MNCs.
- Most ICT companies are SMEs and not technologically sophisticated enough to work in knowledge network with universities.
- University spin out companies are mainly at the early stage of technology development and do not have the extra resources to re-invest themselves in the next stage of technology.
- Scotland's ICT companies do not cooperate much with universities or other research institutes, except at the student level.
- Scotland produces a high number of graduates in ICT, which is an advantage of the region, but many of them leave Scotland after finishing their studies.
- Other barriers to industry-university links are mismatches between industry and academic research in terms of topics, the speed of technology development and cultures.
- Academics lack the motivation to engage in commercialisation activities.

**4. Firm strategy, structure and rivalry/internal organisation of firms and inter-firm relations**

**a. Scotland**

- Scotland's economic structure is largely dominated by the service sector, while the manufacturing sector is experiencing a decline.
- SMEs (with less than 50 employees) represent 98% of the total number of companies in Scotland; medium sized and large companies (50 to over 500 employees) represent 2% of the total companies; but 44% of the jobs are from the large firms.
- Scotland's high cost structure is facing intense competition form other low cost economies.
- Lack of innovative milieu and competitive pressure; companies are 'ignoristic' with each other, but personal relationships tend to be good.

**b. ICT sector**

- Scotland's ICT companies do not have a full local value chain. They only engage in one process/part of the production system.
- Knowledge network is shallow and there is not much knowledge flows among ICT companies.

- Social network is not strong as networking organisations fail to provide informal governance.
- Scotland shows a polarisation of company size and technological capabilities: i.e. there are large ICT companies with low technological capabilities and small to medium sized ICT companies with high technological capabilities (university spin-outs).
- Companies that are medium sized, stable and with full business/production functions are under-represented.
- ICT industry in Scotland is volatile and unstable as large manufacturing companies are vulnerable to competition from other low cost economies, while the birth rate of small design companies is low.
- Inter-firm relationships are relatively weak in Scotland. Companies tend to have strong and long-term customer relationships, but weak and discontinuous relationships with local suppliers.
- Small design companies pursue an offensive technology strategy, but a lack of funds always hinders their expansion and sometimes results in their selling of the company to MNCs.
- Large ICT companies pursue dependent technology strategies, but in order to fend off the competition from other developing countries they have to upgrade their technology and move up the value chain.
- Each ICT company specialises in a niche technological area, having no overlapping/complementary exchange with each other. ICT companies in Scotland neither compete nor co-operate with each other.

## 4.2 Evolution of Scotland's knowledge-based ICT cluster ('meso' level) over a longitudinal period of time (1996-2005)

This section illustrates the constituency building process of the ICT cluster in Scotland at the 'meso' cluster level (level 2 in Figure 4.1). The analysis makes use of Molina's STC diamond of alignment framework. Owing to the case's complexity and its duration over long period of time, this section is divided into four stages: namely, 1) the constituency building stage (1996-1997), 2) the constituency momentum generating stage (1998-1999), 3) the constituency's difficult evolution stage (2000-2003) and 4) the constituency's re-alignment and further advancement stage (2004-2005). The analysis uses the dimensions of the diamond of alignment to assess the state of alignment of the constituency building of the ICT cluster at the end of each of these four critical periods.

### Early Scottish attempts at industrial clustering

Scotland has a very long history of fostering cluster development. According to McCrone (1999), the nearest approach was the development of 'growth points' in 1963. This approach was based on the idea that industrial incentives and infrastructure investment should be given to areas that had a chance of success in attracting industry, such as in the new towns, for example. However, the growth point policy only achieved limited success.[6] The policy was only concerned about location priorities, rather than the inter-firm networks highlighted in the modern cluster theory.

Following the set up of the Scottish Development Agency (SDA) in 1975, Scotland has adopted a 'sectoral' approach to economic development. As mentioned in Appendix 4, industrial policies were designed to concentrate on key sectors, especially those related to high technology, such as electronics, offshore engineering and health care, which were viewed as having 'good potential'. The SDA worked through Locate in Scotland (LIS) to attract direct foreign investment of large MNCs in these target sectors to Scotland. Although the sectoral approach has achieved great success, especially in the creation of employment opportunities in the assisted areas, Reid (1999) comments that the sectoral strategy has been *'too strongly driven by trends in demand to the neglect of the supply side.'* (Reid, 1999, p.18) The sectoral approach did not pay much attention, for example, to supply side factors, such as skills and training, innovation and technology development and to the fostering of entrepreneurship.

In 1991, Scottish Enterprise (SE)[7] was set up by integrating activities in relation to training, economic development and environmental improvement into one administrative body. Danson et al. (1990) point out, the formation of Scottish Enterprise has very important implications for economic development in Scotland. It marked the beginning of the reverse of the conventional regional policies from securing even the geographical distribution of employment opportunities to a new focus on improving industrial efficiency and corporate profitability. A number of actions, including those concerning the supply side of economic

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[6] According to McCrone (1999), the policy attracted two motor plants to be established in Lindwood and Bathgate, but for various reasons, the 'hoped-for' motor cluster has not developed, even though the two companies have stayed for about 20 years.

[7] In December 1988, the Industry Department for Scotland published a White Paper '*Scottish Enterprise: A New Approach to Training and Enterprise Creation*'. This proposed to merge the Training Agency, the Scottish Development Agency and the Highlands and Islands Development Board into Scottish Enterprise. (Danson et al., 1990)

development, were set out in its official strategy paper '*Strategy for the 1990s*'. For instance, a Business Birth Rate Strategy was put forward by SE's Chief Executive, Crawford Beveridge in 1993 (Smith, 1993; Reid, 1999) and relevant policy programmes and initiatives were launched with the specific aim of improving the business birth rate in Scotland.

**Pre-constituency building stage[8] (1993-1995)**

This very early stage is mostly about opening a space in the governance of SE and other government players to transform the ICT-cluster idea into an official policy and thus obtain resources to take the constituency-building beyond the realm of ideas into the reality of industry. Following the publication of Porter's *Competitive Advantage of Nations* in early 1990, the idea of clusters caught the attention of a number of key individuals in SE, including Ron Botham, who took a strategy/research role at SE, Bob Downes, Director of Scottish Business, and Crawford Beveridge, SE's Chief Executive. They were all looking for a fresh approach to economic development for the newly established Scottish Enterprise. It seemed that the concept of clusters was also very much in line with the sectoral industrial focus undertaken by the SDA and the regional development approach of the Conservative Government. Subsequently, in 1992, SE commissioned Michael Porter's Monitor Company to conduct research on clusters in Scotland, primarily on the ICT, and later on the oil and gas industry. The report came out in 1993 (unpublished) and concluded that Scotland's ICT industry was in a very 'vulnerable position' for the following reasons:

1. The MNCs in Scotland could well migrate to lower-cost locations in Eastern Europe and Asia.
2. Scotland could encounter increasing difficulties in attracting new foreign investment as the UK government's incentive package had become 'uncompetitive'.
3. The cycle of innovation was 'very weak' and 'poorly integrated' in Scotland.

In order to tackle these problems, the Monitor Company proposed three routes to secure the future of the ICT industry:

1. To increase the <u>size, sophistication and commercial performance</u> of Scottish-based sub-contractors.

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[8] Part of the information in this section is based on interviews with Heather Sim, SE's Head of Strategy Group and Professor Ron Botham, University of Glasgow, conducted by John Beattie in 2001. The author of this thesis is very grateful to Mr. Beattie for sharing his information.

2. To increase the range and intellectual content of electronic-related products and services developed in Scotland.
3. To increase educational standards and ensure the smooth supply of employee skills to the industry. (Scottish Business Insider, 1993, p.5-6)

Based on the report, it became self-evident that Scotland should develop a knowledge-based ICT cluster that could effectively respond to the threats and opportunities of the specific ICT trends shown in the following Table 4.2

Table 4.2 Technology context for the development of the knowledge-based ICT cluster

| |
|---|
| **1. Commodification of electronic products made in Scotland**<br>The success of Scotland's ICT industry was largely based on high volume, commodity manufacturing of electronic products. However, the commodification of electronic products meant that their outputs suffered from volatile cycles of sales due to business cycles and price decline. Moreover, the growing maturity of manufacturing technology has made production possible in some emerging economies, such as in the Far East and in the Eastern European countries. This has made it difficult for Scotland to win future inward investments in electronic manufacturing. |
| **2. The emergence of system-on-chip technology**<br>Scotland's semiconductor industry was focused on the manufacturing of memory chips and microprocessors[9] which are used by computers. However, as greater sophistication in ICT devices is expected, there is an increasing shift towards smarter, higher-value ASIC and analog products. The latest technology trend is to utilise a greater proportion of the transistors embedded on a chip and to have greater reliance on software, leading to the combining of memory, microprocessor and logic into system-on-chip (SoC) technology. |
| **3. Moving towards a fabless mode of production**<br>The semiconductor industry in Scotland is mainly concentrated on one process—wafer fabrication. However, fabrication plants in Scotland are facing a number of problems. First, annual investment in a fab is more than £30 billion and is increasing at 20% per annum. Facing this high level of investment, the new mode of production is the consortia-owned very large high-volume flexible fab plants or semiconductor companies which shed their own plants and out-source the fabrication process to independent companies under contract. In this scenario, it would be difficult for Scotland to win new |

[9] Memory chips are just one of the four basic types of semiconductor. The others are microcontrollers (mcu), application-specific integrated circuits (Asic) or logic chips, and analog chips. Microcontrollers and analog are the smarter chips. NEC in Livingston made DRAM memory chips for computers, Motorola in East Kilbride made microcontrollers for cars and telephones, while National Semiconductor in Greenock made the analog chips for radio telecommunications.

| |
|---|
| fabrication plants. Second, the Scottish semiconductor plants mainly produce 4-inch to 8-inch silicon wafers. However, this technology soon becomes old and the most advanced technology is for 12-inch (300 mm) wafer. Combined with the previous factor, it is difficult for the existing Scottish fabrication plants to obtain additional investment from their parent companies in order to upgrade their existing plants. |
| **4. New mode of design and production in the ICT industry**<br>Another technology trend concerning the ICT industry is that power and profit will move away from component manufacturers and process developers towards ICT designers and original equipment manufacturers (OEMs), such as system integrators and end users. This trend also reverses the traditional system which ICT vendors designed and sold to the OEMs of electronic equipment. The new mode of organisation is expected to include OEMs and ICT vendors in partnership in working on the design. The implications of this for Scotland are twofold: first, Scotland has to upgrade its ICT sector in the value chain and to concentrate on the design side rather than the manufacturing side. Second, it has to foster closer linkages among ICT companies, especially among suppliers and their immediate users and the system level ICT companies. |
| **5. Greater collaboration and more exports**<br>Most ICT products/components do not stand alone, but need to be knitted or bundled with other technologies and devices before integrating into a final product. The important dimension of 'interoperability' among different technologies/devices prompts ICT companies to develop closer collaborative relationships with each other. Besides, due to the shorter life cycle of the ICT products and their rising costs in R&D, an increasing number of ICT companies enter into technological alliances with each other to share the R&D costs and to secure the first mover advantage. In turn, to cover the high development costs of ICT, many companies seek to achieve a high value volume of sales through exports. |

However, no formal cluster strategy emerged until 1997. The long delay between the report and the implementation of the strategy was due to a number of reasons. First, Monitor Company's report identified about 30 embryonic and potential clusters in Scotland. It took a while for Scottish Enterprise to decide which clusters to develop and how to develop them. Though later four pilot clusters (semiconductors, oil and gas, food and drinks, and biotechnology) were identified, based on the strengths of Scotland's industry, the action plans for these four pilot clusters took too long to complete due to their diverse nature and to the lack of experience of SE in cluster building. Second, the idea of creating clusters confronted strong opposition, both from inside and outside SE, including opposition from some economists inside the SE and the Central government who did not believe in Porter's cluster theory as a regional development concept.[10]

### 4.2.1 Period 1— Birth of the ICT cluster

**From 'idea' to the constituency building stage (1996-1997)**

After three returns of the strategy papers to the SE Board, the approval for the formal adoption of a cluster strategy was finally obtained in 1996 and the Board agreed to establish four pilot clusters. Scottish Enterprise decided to deploy £25 million to finance the development of cluster related projects. In December of 1997, Scottish Enterprise announced its first project for the ICT cluster[11]—the Alba Project, a partnership between Scottish Enterprise and Cadence Design Systems to create a design complex for the next generation of systems on chip design. The project included three major investments for developing system-on-chip technology in Scotland, including 1) a major inward investment by Cadence Design Systems with the hope of generating 1,895 design jobs over 7 years 2) a new independent design complex based in Livingston to facilitate a 'friendly environment' for the design and trading of intellectual property in relation to system on chip design and 3) the world's first System Level Integration (SLI) institute formed by four Scottish universities which would carry out research on SoC technology. (The details of the constituency building process of the Alba Project are discussed in Appendix 5).

The constituency-building process of the ICT cluster started to take shape. However, a number of points related to the formation of the early ICT cluster are worth noting:

Although the ICT industry has developed in Scotland over a period of 30 years, it had become mainly a manufacturing base without substantial R&D and technology development. In order to create a knowledge-based cluster, it required a change in the industrial structure

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[10] Scottish Enterprise's 1996 board paper *Cluster Development* revealed the major obstacles they met at that time: the difficulty of trying to advance on all industry fronts simultaneously at a time when the resources available to SE were being reduced; the need to reprioritise clusters at least in the short run; and the need for the rapid adoption of a more fully integrated and outward looking approach by SE if broad-based progress was to be achieved in the long run. (Peters et al., 2000, p.266)
[11] The pilot cluster for ICT primarily focused on the semiconductor industry and it was called a 'semiconductor cluster'. Later, the concept evolved gradually embracing more ICT technologies, including electronics, microelectronics (semiconductors), optoelectronics and telecommunications, and thus becomes a true ICT cluster. Henceforth, the ICT cluster in this section refers to the semiconductor cluster, unless stated otherwise.

of the ICT sector to attract new players to the scene. Apart from the cluster strategy, other approaches, such as attracting inward investors by means of the allocation of financial assistance (i.e. RSA), and the business birth rate strategy, are still in place today. Therefore, the launch of a cluster strategy also necessitated a re-alignment of the existing economic development approach. Also, SE was the only organisation that played a leading role in the early constituency-building process. The Scottish Parliament and its executing arm, the Scottish Executive, did not come on to the scene until 1999, after the official launch of ICT cluster strategy.

Therefore, one of the concerns at the time was whether or not SE had the sufficient resources (human and finance) and capabilities to kick-start the constituency building process within industry. As one interviewee who is a leader of the ICT cluster team said:

> *'I think in terms of developing the original cluster action plans and cluster maps, it was essentially a question of manpower. It's a question of drawing people together from around Scottish Enterprise and using them as a resource to start the process. And that was all required within Scottish Enterprise'.*

Table 4.3 uses the diamond of alignment to assess the state of the Scottish ICT cluster constituency-building process at the end of the initial 'idea' stage. Since this process is conditioned by the structural factors summarised in the NSI/IC framework in Table 4.3, some of those factors are integrated into the various dimensions of the STC diamond.

Table 4.3 Overview of state of alignment at the end of the 'birth' stage of Scottish ICT cluster

| **Overview of state of alignment of Scotland's ICT cluster by 1997** |
|---|
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• By 1997, the ICT constituency building process counted on a few constituency-builders, who had the vision and determination of pursuing a knowledge-based ICT cluster as a way to improve the innovation, sustainability and competitiveness of the Scottish ICT industry, thus tackling Scotland's vulnerable position in the global ICT market. They had limited resources but a great deal of authority since one of them was the head of SE.<br>• Most of the action during the 'idea' stage concentrated on opening space in the policy governance of SE and thus obtain resources to take the constituency-building process to industry. In this process, they succeeded in aligning (through payment) Porter's Monitor company to produce an important constituent for the 'battle of ideas', namely, an |

authoritative study recommending the cluster policy and identifying ICTs as one of the areas to pursue the build up of a cluster. At the end of this stage, an ICT cluster had become official SE policy with the acceptance of the Scottish government.

**(II) Nature and Maturity of the Technology**

- The focus of the effort to build up a knowledge intensive ICT cluster was the upgrading of Scottish ICT capabilities from mature, lower value-added activities, products and services to the capability to research, design, develop, produce and sell more sophisticated high value added ICT products. The latter technology was very much at the leading edge of ICT development, particularly the focus on system-on-chip and associated technologies in the arena of semiconductors.

**Alignment (1) Governance**

- By 1997, the build up of an ICT cluster in Scotland had become official policy in Scottish Enterprise. This favourable governance however was tempered by the fact that SE was the only organisation to propose the cluster strategy and it was constrained by inadequate knowledge about cluster building and had limited resources. In addition, the cluster approach was not highly favoured by the government, even inside SE.
- The market governance lent support to the idea that Scotland had to do something to upgrade the ICT industry to a more knowledge-intensive content and capacity to produce more sophisticated high value added products. In particular, the commodification of technology has led to the migration of manufacturing to low cost economies, thus posing a threat to the Scottish ICT sector.
- On the other hand, the prevailing governance of the Scottish ICT industry pointed to significant difficulties. For instance, the lack of R&D culture in the ICT industry made the changeover to more sophisticated high value added products difficult in Scotland. Likewise, technology upgrading was difficult as parent companies were reluctant to re-invest in their subsidiary plants in Scotland. Rather, they opted for a fabless mode of production.

**Alignment (2) Nature of the Target Problem**

- The problem faced by the ICT-cluster constituency-building process is simply massive in complexity as it implies a profound transformation of the Scottish ICT industry from a mature, low value-added content and capability to a knowledge-based industry capable of innovation, sustainability and competitiveness with high value-added products and services. Ultimately, this meant a profound change of structure and governance from the condition described above, including lack of R&D, reluctance to re-invest, fragmentation, lack of knowledge-based university-industry interactions, weakness of entrepreneurial culture, etc., etc.

- It also meant to face effectively the threats implied in the ICT trends exposed earlier on in Table 4.2, that is:
  - 1. Commodification of electronic products made in Scotland
  - 2. The emergence of system-on-chip technology
  - 3. Moving towards a fabless mode of production
  - 4. New mode of design and production in the ICT industry
  - 5. Greater collaboration and more exports
- It was a completely open matter whether an SE-led cluster-building process would be able to deliver its ambitious goals. Indeed, there were concerns about SE capabilities to implement effectively the highly complex constituency-building process of making a reality of an ICT knowledge cluster, even because the consensus for the adoption of a cluster strategy was low at this early stage.

**Alignment (3) Target Constituents' Perceptions and Pursuits**

- At the end of the 'idea' stage, the ICT-cluster constituency had almost everybody as a target constituent. Indeed, this approach was very new to Scotland and SE needed to invite a wide range of organizations to join the cluster, including ICT design companies, universities and research institutes, and other government departments.

**Alignment (4) Interacting Technologies/Constituencies**

- Other regional development approaches were still in place, such as the offer of financial inducements (RSA) and support for new business development (Business Birth Rate Strategy). The launch of the cluster strategy would possibly displace or integrate the old systems. Even inside the cluster policy there were various clusters and this could have collaborative as well as competitive implications. All the clusters had the common interest to see the cluster policy supported, while they could compete for the resources allocated to the policy.
- Inside the cluster, the range of technologies was very wide and one of the objectives was to achieve greater interaction along the value chains of research, design, development, production and distribution. In this, there would also be interactions with technological developments taking place elsewhere, for instance, internet and satellite communications.

### 4.2.2 Period 2—Growth of the ICT cluster (1998-1999)

**Constituency building and momentum generating stage**

**1. The establishment of a formal division**

The initial step of Scottish Enterprise was to legitimise the intention of creating clusters through institutionalisation. In 1998, a formal cluster division was formed by Scottish Enterprise. SE's chief executive Crawford Beveridge was primarily responsible for the implementation of the cluster strategy throughout SE and the Local Enterprise Companies (LECs). Bob Downes, SE's Director of Scottish Business, took on a new role as the Director of Cluster Development. Another early cluster champion, Ron Botham, eventually left SE but he still played an informal, educational role to promote the concept of clusters.[12] In addition, cluster teams related to specific industrial sectors. Each cluster team had its own director who was responsible for developing the cluster community. A cluster community is normally constituted of a group of people from academia, industry and other members of the Scottish Enterprise who get together on a regular basis to discuss the issues in relation to how to advance the constituency-building process of the ICT cluster.

**2. Promote the cluster concept and mobilise key players**

In order to mobilise the key players to participate in the constituency-building of the knowledge-based ICT cluster, a communication strategy was undertaken by Scottish Enterprise in 1998 to introduce the basic concepts of clusters to the key players and wider community. However, the task was not an easy one. The first problem encountered by Scottish Enterprise was to explain the cluster concept to the cluster community and other stakeholders. Since the concept of 'clusters' originated from academic research (to a certain extent, the concept was quite 'fuzzy' and not very well established) and was relatively new to Scotland, the SE's cluster team soon discovered that people in industry found it difficult to understand. A leader of the ICT cluster team said:

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[12] At the time when the cluster strategy was launched officially in Scotland, Ron Botham worked as a freelance consultant and Senior Research Fellow at Glasgow University. He wrote a number of papers in journals (i.e. Scottish Affairs) based on his research of clusters when he worked with Scottish Enterprise.

*'Remember that cluster is an artificial word, it's not a word that people recognise…if you mean in the way Michael Porter defined, if that's what you mean, then companies don't understand that. That's no reason why a company should understand it.…'*

The difficulties in communicating the cluster concept to the wider public did cause problems to the promotional effort of the cluster strategy. Misunderstanding of the concept by the general public was evident at that time. For instance, according to a news report on 16 November, 1997, the concept of clusters caused much confusion and resistance.[13] In particular, many industry groups mistook it as the traditional 'picking winner' approach. Bob Downes, the cluster director of SE explained to the media: '*SE is not picking winning companies or specific technologies, but is focusing on market and technology areas where Scotland can build an advantage.*' (Scotland on Sunday, 16 November, 1997)

Another issue was in relation to motivating companies to become involved in the ICT cluster. While participating in clusters would not give companies immediate material benefits like the RSA financial assistance, the members of the SE's cluster team had to persuade companies with their vision of future benefits through discourse. A cluster team leader described how they mobilised the private sector;

*'You would say to a company, in order to run your business really well and to grow to develop good business, you need good access to research coming out from the universities, you need good access to venture capitalists, or you need good access to people who have complementary technology and you need, you say, these things can happen in Scotland. You need to provide a meaningful way of describing things, rather than just talk about clusters because companies just don't understand that.'*

Building a cluster was different from introducing a traditional industrial policy, which only involved a core industrial group. Instead, Scottish Enterprise had to mobilise a much wider group of people who were at the core of the industry (such as the ICT companies) and those from the periphery (such as academics and other government departments) to participate in the cluster. These diverse groups of people had different aims, interests and motivations, thus creating consensus and cooperation among them was difficult to achieve. As a leader of the ICT cluster team explained:

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[13] Criticism of the cluster strategy was triggered by an announcement of withdrawal by Rolls-Royce, followed by the news that the Labour government intended to pump in £200 million to save the company. The media started to criticise the cluster strategy as a revival of the government practice of 'picking winners' in the 1960s and 1970s.

‘*That’s probably where the largest amount of effort, rather than help, was, in trying to get them to cooperate because not everyone sees the world in the same way as we see it, so well the individual company could say yes, but not necessarily act in the way that we would want.’*

Interviewees from the cluster team made the particular point that cooperating with the universities was problematic from the outset. This may have been caused by the distinctive culture of universities which was largely different from other organisations, including the cultures of industry and government. A leader of the cluster team said:

*‘By and large, people find universities are difficult to deal with, because culturally and organisationally, universities are very different from organisations like Scottish Enterprise and commercial organisations… most academics have what they call academic freedom, which means they don’t like being told what to do. I think that makes it very difficult for people to establish organisational relationships [with them].’*

This problem in relation to cooperating with universities in the constituency building process of the ICT cluster was revealed in the 1999 *Report of the Knowledge Economy Taskforce.* In chapter 3, it states:

‘*…the approach is not intended to constrain academic freedom to pursue curiosity driven research…however, clustering does mean looking for areas of complementarity between our basic research strength and our business potential.’* The report also recommended that ‘*The commitment of higher education Principals is essential if their institutions are to contribute fully to cluster development’.* (The Scottish Office, 1999)

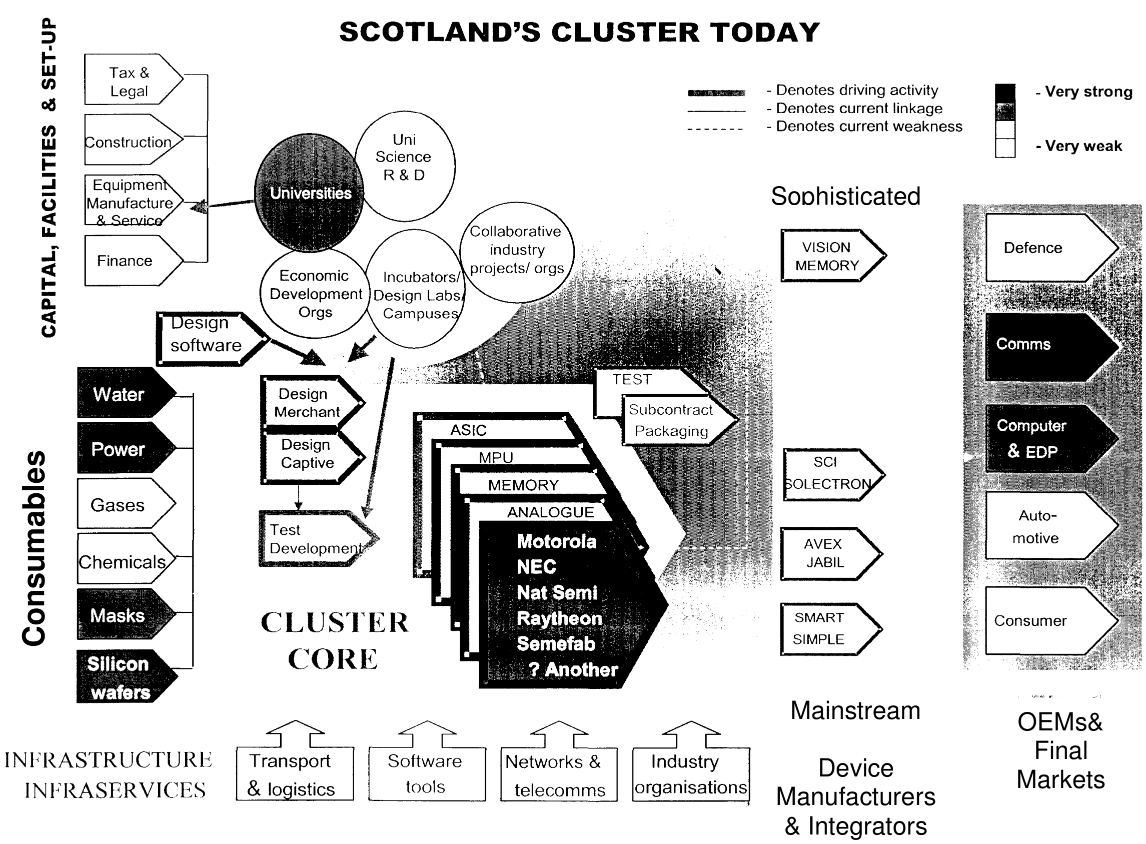
**3. Strategy-making process of the ICT cluster**

Scottish Enterprise sought to promote the ICT cluster through its policy programmes. In order to do so, a group of key members who formed the ICT cluster community were involved in drafting the strategy and in designing the action plans. Such a group, led by Scottish Enterprise, was also responsible for identifying the goals and strategic priorities for the ICT cluster. The strategy making process of the ICT cluster made much reference to the Monitor Company’s report on the ICT industry. Its ultimate aim was to tackle the ‘problems’ highlighted in the report. In other words, the strategy was driven by the ‘target problems’—a recognition of the vulnerability of the ICT manufacturing industry in Scotland. Scottish Enterprise mainly adopted a ‘diagnosis approach’ and the key steps leading to the formulation of specific strategies and action plans are outlined as follows:

### a. Mapping of the ICT sector

In preparing the strategies and action plans for the ICT cluster, a number of planning techniques were used such as mapping, bench marking and scenario planning (Scottish Enterprise, 1999). First of all, to generate an understanding of the actual situation in Scotland's ICT sector, the technique of mapping was applied. The process started with an analysis of all the 'ingredients' or 'constituents' involved in the ICT clusters, such as the key industrial players, supporting institutions, infrastructures, markets etc. Then, the linkages among these 'ingredients' were mapped visually and these linkages' level of strength was assessed. A cluster map for the Scottish ICT sector is produced in Figure 4.2.

Figure 4.2 Scottish Enterprise's mapping exercise of the strengths and weaknesses of the ICT cluster (Source: Scottish Enterprise, 1999)



At the centre of the map is shown that the core of the Scottish ICT cluster was a group of semiconductor manufacturers. On the left of the map are the supplier base and the infrastructures, including the utilities and power etc. On the right of the map is the end market. The map also depicts the related and supporting industries, such as the different research organisations and networks, logistics, transportation etc. The map is a coloured picture. Those items marked in a dark colour represent the strengths and those in white are weaknesses. The cluster map showed that in 1999, Scotland's ICT sector had strong manufacturing, good access to water, power and gas, but was relatively weak in design and testing. As explained by a leader of the ICT cluster team, the cluster map could be of use for developing clusters in two ways:

> *'In order to create sustainable innovation activities, you need all the ingredients that Michael Porter talks about and the way we look at it is not only do you need all the ingredients, you need the linkages between the various bits. So <u>what we look at is, are there any ingredients missing</u>? If the answer to that is yes, how can <u>we develop those ingredients</u>; it might be through indigenous companies start ups, it might be through bringing inward investments, or whatever. And secondly what are the strengths of the linkages between the various parts of the clusters? <u>If those linkages are weak, what can we do to strengthen those linkages?</u>'*

**b. Defining cluster goals and strategies**

The results drawn from the cluster map represented a starting point in defining more systematically the broad 'target problem' for the ICT sector in Scotland, that is, the problem of the missing or weak innovation element in Scotland's broad ICT value chain, in the context of evolving ICT trends. The motivation for the launching of the cluster strategy was to tackle this 'target problem'. The diagnosis process began with defining the broad <u>target</u> for the cluster, that is, the desired situation at which the cluster-building process aimed to arrive. From 1998 to 1999, the cluster community took part in a series of meetings to develop the target problem into a <u>vision</u> and <u>goals</u> for the ICT cluster over the period of the next five to ten years, along with the specific strategies to make them come true.

In the case of the Scottish ICT cluster, the Scottish Enterprise's webpage of 2000 stated that the ultimate <u>vision</u> was to '*secure the country's position and reputation as one of the world's most enlightened locations for the next generation of systems and silicon designers,* *developers and manufacturers*'[14] (Scottish Enterprise, 2000). The goal of the ICT cluster strategy was to '*develop innovation as the core of its ICT industry by exploiting the potentials of design and research from the industry, universities and research institutes'*. A measurable target also has been set up for the ICT cluster. As described in Scottish Enterprise's strategic document, it was '*to ensure that there will be at least 14,500 people working in the microelectronic industry*' and among them, *'at least 5,000 employees in design, development and applications with a further 5,000 in manufacturing and 4,500 in supporting industries.*' (Scottish Enterprise, 1999)

After the goal and targets of the ICT cluster had been defined, the ICT cluster community began to design the appropriate methods or strategies to reach this goal. As a leader of the ICT cluster team explained:

> *'So much of the early effort was in identifying what was in Scotland and we tried to identify some strategies that everyone could buy into and then in trying to enact these strategies so that action resulted from those strategies.'*

According to two early cluster builders, Ron Botham and Bob Downes, the strategy making process also provided a means for the cluster players to align or reconcile their interests with each other, so that they were able *'to establish a shared vision and understanding of what needs to be done to increase the cluster's innovation, competitive advantage and capacity to generate sustainable employment and to produce an agreed and widely supported action plan.'* (Botham and Downes, 1999, p.55) After a series of meetings and discussions with the cluster community, six key strategies were identified, including the following in Table 4.4:

Table 4.4 Key strategies for constituency building of the ICT cluster in Scotland (Source: Scottish Enterprise, 1999)

| **Sub-areas** | **Key strategies** |
|---|---|
| Manufacturing | • Sustain and develop Scotland's manufacturing base. |
| Research | • Raise the quality and quantity of research, design and development in microelectronics. |

[14] This description has already been removed and can now no longer be found on Scottish Enterprise's webpage.

| | |
|---|---|
| Design | • Exploit the benefits of Project Alba and existing embryonic and unexploited strengths, especially in design. |
| Marketing | • Develop market links at home and away. |
| Embedded software | • Exploit the opportunity for software and its relationship to design strengths which exist in Scotland. |
| Supplier | • Develop better and more cohesive local and international networks at the core of the cluster and then backwards into the supplier base. |

### c. Identification of necessary actions

In pursuit of these six strategies, Scottish Enterprise developed an action plan identifying about 70 individual actions, as summarised in Table 4.5. These actions were mainly aimed at strengthening the various aspects of the ICT industry. The priorities for the ICT cluster were to enhance the design and testing elements in the ICT industry, to exploit academic research and strengthen the links with customers and local suppliers. Interestingly, the action plan at that time also included a programme to set up a foundry for electronics, to be made or assembled in Scotland. However, this programme has never been carried out due to the rapid deterioration of the chip manufacturing industry in Scotland after 2000.

Table 4.5 Summary of Scottish Enterprise's action plans for the ICT cluster in 1999 (Source: Scottish Enterprise, 1999).

| **Action plan for the ICT cluster in 1999** |
|---|
| *Manufacturing: sustain and develop Scotland's manufacturing base*<br>• Sustain existing manufacturing core<br>• Broaden Scotland's portfolio of microelectronics manufacturing<br>• Spinout new corporate structure<br>• Investigate the feasibility of a wafer foundry in Scotland<br>• Investigate the feasibility of a fabrication centre for semi/opto small companies |
| *Research: raise the quality and quantity for research, design and development in microelectronics*<br>• Retain and attract a greater portion of research funding<br>• Increase the number and quality of collaborative programmes with world class companies<br>• Establish more joint venture incubation, application and product development laboratories focused on partnerships in microelectronics<br>• Develop ambitious cohesive research strategies<br>• Benchmark Scotland's current and potential capabilities in the R&D of semiconductors and |

| |
|---|
| microelectronics<br>• Develop a community in microelectronics and develop a world class reputation |
| *Design: exploit the benefits of the Alba Project*<br>• Create an efficient international and open market infrastructure for the trading of semiconductor intellectual property by establishing the Virtual Component Exchange (VCX)<br>• Deliver a sophisticated engagement process with relevant overseas companies on the benefits and opportunities of locating in Scotland<br>• Develop the Institute for System Level Integration (ISLI) to world-class status<br>• Undertake generic and targeted marketing of Scotland as an innovative design location<br>• Develop the physical structure and shared facilities centre at the Alba Campus in Livingston<br>• Investigate the feasibility of a microelectronic test centre |
| *Markets: develop market links home and away*<br>• Energise corporate networks and link them with local opportunities for product development<br>• Provide development assistance for local start-ups and SMEs to operate globally<br>• Attract key individuals and companies to accelerate product technology growth opportunities in Scotland<br>• Develop a consistent approach to marketing Scotland's high tech image abroad |
| *Embedded software: exploit the opportunities for software*<br>• Key projects on embedded software<br>• Assess skills requirements and partnership with academia to meet those requirements<br>• Identify targets for FDI projects<br>• Develop opportunities for spin-outs, either from academia or existing companies<br>• Investigate infrastructural requirement e.g. incubators |
| *Supplier: develop better backward networks into the supplier base*<br>• Develop the Scottish Semiconductor Supplier Forum<br>• Develop a strategic alliance between global companies and Scottish-based operations |

The resultant action plan document was circulated to the relevant cluster stakeholders through an extensive consultation process to allow people to comment on the draft before it was finally authorised by the Scottish Enterprise management board. In other words, this document was a crystallisation of the state of alignment of the constituency at that point in time. In fact, in the cover of the cluster strategy paper, it was made clear that *'[it] is emphatically not a Scottish Enterprise document in and for itself. It aims to be a framework in which all members of the cluster can perceive and progress their main strategic priorities.'* (Scottish Enterprise, 1999)

## 4. Cluster strategy in action

The actions outlined above were translated, through the process of institutionalisation, into many publicly funded projects and initiatives in Scotland. Some of these actions are specific to the ICT sector, others have a wider relevance. For instance, the required actions for enhancing the design aspect of the ICT sector actually became the various ICT programmes contained in the Alba Project (see Appendix 5 for details). On the other hand, the actions for exploiting university research were translated into the Proof of Concept Funds and Scottish Enterprise/Royal Society of Edinburgh Fellowships, as mentioned in Appendix 4. These funds were available for companies falling into the cluster sectors, including, but not limited to ICT. In addition, the cluster strategy was also strengthened by a number of non-cluster specific programmes that were already in place in Scotland. For example, the SMART and SPUR awards organised by the Scottish Government (Scottish Office) were complementary to the cluster strategy in supporting companies to develop R&D projects. Table 4.6 summarises the major initiatives and projects of relevance for the knowledge-based ICT cluster in Scotland.

Table 4.6 Summary of the knowledge-based ICT cluster policy initiatives by Scottish Enterprise in 1999

| | |
|---|---|
| ***Funding:*** | |
| **Proof of Concept Fund (PCF)** | Operated by Scottish Enterprise since 1997, it consists of a total investment of £5.2 million to fund early stage ideas or research in the pre-company formation stage at the universities within the cluster areas. |
| **Scottish Enterprise/Royal Society of Edinburgh Enterprise Fellowship (EF)** | Started in 1997, SE/RSE fellowship gives academic scientists a period of about 12 months to test out their ideas. The fellowship covers the costs of employment in the hope that a specific idea can blossom into a business opportunity. |
| ***RD&D Infrastructure:*** | |
| **Alba Campus (ACa)** | Opened in 1999, the Alba Campus is located in Livingston with land of 96 acres. It has been created to offer companies in the ICT design industries an ideal working environment. The Alba Campus is being developed under a public-private sector joint partnership, including Scottish Enterprise Edinburgh and Lothian, Miller Developments and the Bank of Scotland (Miller BoS). |

| | |
|---|---|
| **Alba Centre (ACe)** | Located in Alba Campus and opened in 1999, the Alba Centre is Scottish Enterprise's key initiative to support the ICT design community. The Alba Centre was created in partnership with government, industry and academia and dedicated to 'system on chip' technology and design. The Alba Centre hosts the Institute for System Level Integration, the Scottish Embedded Software Centre and the Virtual Component Exchange. It also provides business accommodation and support for electronic and related design firms. |
| **Institute for System Level Integration (ISLI)** | Founded in 1998, the ISLI at Alba Centre was formed as a partnership between Scottish Enterprise and four of Scotland's leading universities—Edinburgh, Glasgow, Heriot-Watt and Strathclyde, with the aim of providing training, research and technology related to system level integration. It offers postgraduate education and professional training in fields such as electronic engineering, computer sciences, and semiconductor testing and research, and supports the development of new technologies through its research work. |
| **Virtual Component Exchange (VCX)** | Set up in 1998, the VCX at the Alba Centre helps developers and users trade virtual components and deal with the business and legal issues involved. Its web-based system offers a structured list of virtual components which enables users to choose the correct ones. It also provides tools for creating business models and contracts which can help developers and users to collect and distribute royalties. |

## 5. Governance of the ICT cluster

Botham and Downes, two of the original constituency-builders of the Scottish ICT cluster, pointed out:

> '*the cluster strategies and action plans are based on a more comprehensive, focused and integrated approach with greater emphasis on creating and <u>lubricating networks</u> and <u>cluster governance</u>.'* (Botham and Downes, 1999, p.55)

Up to this stage, the essential contribution of Scottish Enterprise in terms of governance of the ICT cluster was to actively engage all the relevant players to work towards a shared cluster agenda. All players who may have had contributions to make related to various aspects of innovation and the technological development of Scotland's ICT sector were brought together by the cluster strategy. Many of these players had had few opportunities for dialogue and collaboration before. Through involving a wide range of players in setting the agenda for the ICT cluster, Scottish Enterprise took on the role of intermediary to facilitate the building up of initial contacts and linkages among these diverse groups of players.

Having established a cluster strategy, Scottish Enterprise began its holistic strategic approach linked to economic development. The development of clusters necessitates joined-up thinking and cooperation across different governmental departments and sectors, as their action in one part of the cluster map may relate to or affect the others. For instance, Scottish Enterprise worked with Locate in Scotland to attract major foreign design companies to start operations in Scotland. The presence of these inward investors mutually reinforced the cluster strategy by attracting highly skilled people to Scotland. The provision of funding by Scottish Enterprise strengthened the entrepreneurial culture and encouraged university spin outs and start ups. Another aspect in enhancing the cluster dynamics included the fostering of an ‘innovative’ culture for the region. Schools, colleges of further education and higher education institutions were essential vehicles for delivering training themes such as lifelong learning, up-skilling and e-learning, all of which could be regarded as conducive to the development of a ‘learning’ culture in the region. In short, many generic policies were linked up by the cluster strategy to capture their synergies in order to support economic development.

Apart from its contribution to formal governance, Scottish Enterprise also set up the Scottish Electronic Forum (SEF) to facilitate the development of informal governance of the ICT cluster. Operating as an industrial-led organisation, SEF’s main function was to attract ICT companies to Scotland, including competitors, to talk to each other on subjects related to the further development of the ICT industry, such as issues on transportation, education, training and linkages with local suppliers etc. and to reach a consensus on those issues. Through participating in the SEF, industrial players were not only able to communicate and understand each other better, but a sense of being a vital part of the ICT cluster was also generated. Ultimately, this could enhance the ICT companies’ willingness to collaborate and participate in the implementation of the cluster strategy.

### 6. Building of momentum

At this point, the development of the cluster had already moved from the planning phase to the action phase. In the late 1990s, efforts to advance towards a knowledge-based ICT cluster began to acquire momentum. As shown in Table 4.7, following the successful launch of the ICT cluster at the end of 1997, Scottish Enterprise started to flesh out a number of other clusters, firstly one specialising in food and drink, and latterly on biotechnology, and oil and gas industries in the period 1998-1999. Scottish Enterprise also embarked on rolling out the second wave of potential clusters, including optoelectronics, forestry, tourism, creative industry and software etc, which were all targeted for the official launch in early 2000. On the one hand, this reflected that the cluster strategy was beginning to gain more support and recognition from the Scottish Government, but on the other hand the overtly ambitious stance adopted by Scottish Enterprise in launching the cluster strategy also led to its downfall in later years.

Table 4.7 Summary of the major developments of the cluster strategy in Scotland (source: The Scotsman, Scotland on Sunday, 1997-1999).

| Year | Major Development |
|---|---|
| **1992-1993** | Monitor Company commissioned by Scottish Enterprise to conduct research and identify Scotland's key strengths in a fast globalising market. |
| **1994** | Pilot study on semiconductor, oil & gas, food & drink and biotechnology clusters. |
| **Nov 1997** | Cluster approach adopted by Scottish Enterprise; semiconductor cluster was launched, while studies on four other clusters including creative industry, optoelectronics, forestry and tourism were launched. |
| **Dec 1997** | Announcement of Alba Project, the target being to create 4,000 jobs in microelectronic design. |
| **Jun 1999** | Launch of food and drink cluster, the target being to create 6,000 jobs in Scotland. |
| **Nov 1999** | Launch of biotechnology cluster, the target being to double the number of companies and create 9,000 jobs. |
| **Dec 1999** | Announcement of plan to build a creative industry cluster in Scotland in the following year |

## 7. Crisis of the ICT cluster

### a. Public resistance to the cluster strategy

The first crisis of the ICT cluster began to surface in late 1998. It was triggered by a series of job cuts in the ICT sector caused by the relocation and retreat of foreign ICT manufacturing companies[15]. The resulting unemployment prompted massive criticism of the cluster strategy as being one that favoured high technology (high value) sectors while forfeiting the traditional (low value) ones. The Scottish Council Policy Forum led the attack and urged Donald Dewar, the Secretary of State for Scotland (later to become the first First Minister of Scotland) '*to strike a greater balance between encouragement for high technology and more 'traditional' manufacturing such as textile and engineering.*' (Scotland on Sunday, 18 October 1998)

Bob Downes, the Director of Cluster Development was reported to have been '*amazed there is so much resistance to the concept*'. He clarified to the press that *'I have never talked about hi-tech and traditional industries, people have just put words in my mouth.'* (Scotland on Sunday, 18 October 1998) It seemed the accusation against the cluster strategy stemmed from a 'misunderstanding' of the concepts of cluster. As highlighted in the newspaper:

> '*As with 'clusters', 'added value' and other concepts bandied around by the inner circle, few people have a clue what they are talking about. The language obfuscates a useful way of looking at the world and responding to the changing marketplace.'* (Scotland on Sunday, 18 October 1998)

In addition, the newspaper revealed that there was a misalignment between the policy makers' goal of advancing to a 'knowledge economy' and the general public's interest in securing their jobs. To the general public, developing a knowledge-based cluster meant that only a small number of highly skilled jobs could be secured, while a larger number of low-skilled job would be lost. The fear of job losses generated an anti-supportive atmosphere before the cluster strategy could gain full momentum. A newspaper quote of the time stated:

> '*The fear of the knowledge economy is leaving thousands behind, producing mass insecurity and damage… Beyond national value though, people would like the opportunity to behave in their own self-interest.*' (Scotland on Sunday, 18 October 1998)

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[15] Examples of ICT companies which shed jobs in 1998 were Lite-on, Compaq/Digital, Viasystems, National Semiconductor, Motorola, Siemens and Fujitsu (Scotland on Sunday, 18 October, 1998).

**b. Deepening of the crisis and the emergence of a 'new' policy focus**

The public attack on the cluster strategy generated enormous pressure on the Scottish government as they attempted to pacify the discontented by solving the employment problem. As reported in the newspaper, in December 1998, Donald Dewar, the Scottish Secretary, and Lord Macdonald, the Scottish Industry Minister, issued guidance[16] to Scottish Enterprise on setting their new goals for the new millennium. In a letter to the SE chairman Sir Ian Wood, Mr. Dewar said the agency's goals were to '*encourage innovation and an inclusive approach to the disadvantaged*.' (see Table 4.8 for specific targets).

Table 4.8 New targets for Scottish Enterprise for the millennium (Source: The Scotsman, 9 December 1998).

- Help set up 100,000 new businesses over the next ten years and ensure that more of them survive for longer.
- Broaden the base of the Scottish economy.
- Promote the 'clustering' of companies by sector.
- Encourage coordination with university and research institutes and increase secondment from companies to schools and colleges.

In association with this new target, Scottish Enterprise was asked to develop a new strategy to encourage innovation, to promote enterprise and lifelong learning and to secure a modern and inclusive economy. This incident had a significant impact on Scottish Enterprise's cluster strategy. First, although it recognised clustering among the four priorities, the target of the new strategy—creating 100,000 new businesses in ten years—was different from that of the knowledge-based cluster, which aimed at enhancing the level of innovation in the industry (not company creation), even though one might argue these two targets were complementary. Second, the new targets were naturally prone to new actions. However, Scottish Enterprise was not able to receive extra resources to achieve these goals, apart from its annual budget of £450 million.[17] Without the additional resources Scottish Enterprise required, then a decrease of available resources for the cluster strategy became a possibility.

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[16] The guidance is set out in the New Deal programme to help the unemployed find work. (The Scotsman, 9 December 1998)

[17] Lord Macdonald told a Westminster press conference that SE would not be receiving additional resources beyond its £450 million budget. He explained, '*Rather than just giving a lump sum of money and saying do with it what you will, let's get more focused.*' (The Scotsman, 9 December 1998)

More importantly at that time, the cluster strategy was just newly established and had not yet been widely recognised and understood by the general public. Therefore, the launching of new targets and their associated strategies could cause confusion to people. In particular, the idea of 'social inclusion' was not entirely originated or compatible with the cluster concepts. The former concentrated on 'equal development' while the latter highlighted the importance of 'discriminative support'. Given the political and economic pressure at that time, Scottish Enterprise finally announced a new strategy in early 1999 for the Scottish economy that would be driven by '*knowledge, innovation, inclusion and competitiveness*' (Scottish Enterprise, 1999).

**Launching of an 'extended' strategy**

The new strategy had dual aims: '*to build a 'knowledge based' economy, focussing most effort on building up clusters of favoured growth industries while promoting 'social inclusion' in growth by taking active steps to tackle unemployment and disadvantages.'* (Scotland on Sunday, 17 January 1999) Although it was said to be a new strategy, it might be more appropriate to view it as an 'extended' strategy, within which, the cluster strategy remained at its heart, while a number of key actions for creating clusters were retained. (see Table 4.9). It could be said that the cluster strategy has grown and expanded and that new policy objectives and programmes were added to the original framework. For example, new initiatives, such as Technology Venture Initiatives and Scottish Equity Partnership were schemes to support the growth of indigenous technology companies, including those that were spun out from Scottish universities.

Table 4.9 Summary of Scottish Enterprise's 'new' strategy for supporting innovation and new business development in Scotland (source: Scottish Enterprise, 1999)

- Through the Technology Venture Initiative, 150 new spin out companies and 11,000 jobs were to be created in Scotland, 8,000 from existing companies and 3,000 from new companies over a period of ten years. The Initiative aims to commercialise the science and university research base.
- *A new initiative to make Scotland a world centre for the design and development of the microelectronics industry—the latest technology which would revolutionise the products*

*and services - was taken for granted.*

- Encouraging greater innovation and growth in companies through SE's £25 million Scottish Equity Partnership Fund and the £2 million Scottish Technology Fund which would provide seed capital for embryonic businesses.
- *Encourage both hi-tech and traditional small and medium sized indigenous businesses to apply innovative processes, products, technology and knowledge to their businesses.*
- *Cluster action plans to improve innovation and competitiveness in industries with the potential to operate in global markets. Pilots in the biotechnology, semiconductors, energy and food sectors are already underway.*
- *Supporting and helping to create innovation networks such as the Scottish Games Alliance, the Scottish Software Federation and the Scottish Electronics Forum.*
- *Winning high quality inward investment—such as Cadence, the first tenant in the Alba Centre at Livingston, which would create 1,700 jobs and increase the level of research, design and development in existing investors.*
- *Increasing exports, international joint ventures and outward investment by Scottish companies—for example, by expanding the network of software centres in the United States.*
- *Nurturing potential global companies who can expand their operations into overseas markets from a Scottish base.*
- Encouraging organisations to adopt more sustainable approaches.

*Words in *italic* denote the initiatives contained in the original ICT cluster strategy.

**c. Detour for the cluster strategy—revival of inward investment approach**

A detour for the cluster strategy was the revival of the 'inward investment approach'. The unemployment problem caused by the deterioration of the ICT manufacturing industry, coupled with the difficulties and slowness in proceeding with the cluster strategy, led to discussion over the revamping of the programmes for the Regional Selective Assistance (RSA) within the Scottish government. Given the past achievements of the RSA in job creation and its former success in attracting world leading system-on-chip design company Cadence Design - which promised to employ 1,900 people in Scotland - political parties, such as Scottish National Party and the Liberal Democrat Party, began to urge the government to attract more higher-value projects through using the RSA as an incentive.

In a newspaper article of the time, Scottish Enterprise's Chief Executive, Crawford Beveridge, one of the proponents of the RSA, explained: '*the key is to balance the need for a* *large number of jobs with a greater emphasis on skills*'….*we need an incentive system to match with our ambitions*'. (Scotland on Sunday, 14 February, 1999) Throughout the period 1998 - 2000, Scottish Enterprise and Locate in Scotland proactively persuaded a number of inward investors to open design centres in Scotland, including Intel, Atmel and Epson. On the one hand, therefore, attracting inward investors to Scotland could be regarded as a short-cut or fast track to solve the target problem—namely, the lack of design capabilities in the ICT sector. However, on the other hand, the inward investment approach could do little to improve the technological capabilities of the indigenous ICT companies. The revival of the inward investment approach became a trade-off between a quick fix and longer term results. Unfortunately, Scottish Enterprise favoured the former and this became a detour for the cluster strategy. When Scottish Enterprise latterly discovered that this quick fix approach did not work, it took much time and effort from them to get back to its original strategy and pursue its original goal.

**d. Departure of cluster builders**

The Scottish cluster strategy was shaken up by the departure of its two main constituency-builders. Bob Downes, the chief architect of Scottish Enterprise's cluster strategy, left the post as the Director of Cluster Development in 1999, two years after the strategy had been launched. (The Scotsman, 8 July, 1999) By the time he left, only clusters for ICT and food and drink industries had been set up. A third cluster for the biotech industry was due to be established in late 1999 and other clusters such as creative industries and tourism had also been lined up. In January 2000, another cluster leader, Crawford Beveridge also announced his resignation from the post of Chief Executive of Scottish Enterprise. Their departures at a time when the cluster strategy had just begun to take off hampered the implementation of the strategy in terms of losing vital leadership, while affecting morale and belief in the cluster development.

Table 4.10 Overview of alignment conditions of the Scottish ICT cluster at the end of its growth phase

| **State of alignment of the Scottish ICT cluster at the end of its growth phase** |
|---|
| **(I) Constituents' Perceptions, Goals, Actions and Resources** |
| • A formal cluster division with a cluster director had been put in place inside SE, giving for the first time governance and greater presence and legitimacy to the policy of cluster |

development; a cluster community had taken shape with players from industry and academia, stimulated by SE to help set an agenda for the ICT cluster.

- Informal governance was provided by the Scottish Electronic Forum, where key industry players got together to share dialogue and information.
- A mapping exercise to seek an understanding of the presence of ingredients or constituents for cluster development had been conducted by SE.
- Target problems were translated into the goal of the ICT cluster, namely to develop innovation as the core of the knowledge intensive industry and measurable ambitious targets were outlined, for instance, at least 14,500 people working in the microelectronic industry and, of these 'at least 5,000 employees in design, development and applications.
- Specific strategies and associated actions to achieve the targets were identified.
- Publicly funded cluster support programmes and initiatives were rolled out (e.g., Alba Campus, Alba Centre, Institute for System Level Integration, Virtual Component Exchange) and momentum began to build up
- Problems begun to emerge with changes in SE's policy (See dimension 1) that forced an expansion of focus to innovation, inclusion and competitiveness.
- The two leading constituency-builders left the clustering process by the end of this period, with consequent loss of authority and drive.

**(II) Nature and Maturity of the Technology**

- The content of this dimension remained very much the same as with the previous phase. That is, the focus of the effort to build up a knowledge intensive ICT cluster was the upgrading of Scottish ICT capabilities from mature, lower value-added activities, products and services to the capability to research, design, develop, produce and sell more sophisticated high value added ICT products. The latter technology was very much at the leading edge of ICT development, particularly the focus on system-on-chip and associated technologies in the arena of semiconductors.

**Alignment (1) Governance**

- Major changes in Scottish economic policy added the goal of inclusion to SE's policy scope, thus expanding its goals beyond innovation and strengthening of knowledge-intensive industries. The new target became to create 100,000 new businesses. Since financial resources remained at £450 million, this change in SE's policy meant a dilution of emphasis and interest in the ICT cluster strategy, and all other clusters for that matter.
- Scottish Enterprise attempted to cooperate with other government departments in developing a holistic approach for economic development through the cluster strategy.
- The issues of governance concerning the evolution of both the ICT market and the

Scottish ICT industry remained the same as in the assessment at the end of the previous phase.

**Alignment (2) Nature of Target Problem**

- The massive and complex problem faced by the ICT-cluster constituency-building process became even more complex given that the clusters now had to contribute to the creation of 100,000 jobs along with, or as part of, the profound transformation of the Scottish ICT industry from a mature, low value-added content and capability to a knowledge-based industry capable of innovation, sustainability and competitiveness with high value-added products and services. This still meant profound changes of structure and governance in the Scottish ICT sector to improve R&D, investment, knowledge-based university-industry interactions, entrepreneurial culture, etc., etc. But it meant it not just to improve innovation and competitiveness but also inclusion of disadvantaged people through massive increments in job opportunities.
- It was an even more open matter whether an SE-led cluster-building process would be able to deliver in the face of such mounting complexity. One way SE knew for fast employment creation was foreign direct investment, so it tended to fall back on this option.

**Alignment (3) Target Constituents' Perceptions and Pursuits**

- Advancing in the transformation of target constituents into proper constituents of the ICT cluster was proving difficult. First the 'cluster' concept was not easy to understand and communicate and this led to a mis-alignment of perceptions with the cluster strategy facing much criticism from the public as being merely the revival of the 'picking winner' approach.
- At this stage, it was difficult to motivate ICT stakeholders to participate as they saw no tangible benefits in the cluster process for themselves. Most of the argument about vision and goals had no immediate direct economic or commercial benefits for the target organisations.
- The research base in Scotland was at universities. However, cultural differences made networking with the higher education sector difficult to achieve. The Scottish Office tried to encourage more commitment from the higher education sector towards cluster development.
- In order to develop the design capability, Scottish Enterprise attempted to attract foreign ICT design companies and a highly skilled workforce to Scotland. The numbers attracted however did not match the original expectations.
- The new strategy of encouraging new business development required the involvement of private investors such as VCs and business angels. This means SE has to seek to align the goal of the cluster to that of the investors who are the target constituents of the ICT

| |
|---|
| cluster. |
| **Alignment (4) Interacting Technologies/Constituencies**<br>• The massive job losses at the end of the 1990s led to the revival of the 'inward investment approach', while the RSA was used as a means of attracting inward investors and job creation. This reduced the resources available for implementing the cluster policy.<br>• The 'new' strategy announced by Scottish Enterprise in 1999 created greater competition with the cluster strategy for resources, especially as SE was not given any extra resources to fund the revised strategy.<br>• Scottish Enterprise was too ambitious in its cluster strategy; eight clusters were too many for Scotland and this inevitably led to the dilution of available resources for each one of them.<br>• Just as in the 'diamond-of-alignment' assessment of the previous stage, inside the cluster, the range of technologies was very wide and one of the objectives was to achieve greater interaction along the value chains of research, design, development, production and distribution. In this, there would also be interactions with technological developments taking place elsewhere, for instance, internet and satellite communications. |

### 4.2.3 Period 3—Economic and ICT Cluster Downturn (2000-2003)

**Constituency's difficult evolution stage**

**1. Limited growth in the early 2000**

In July 1999, the Scottish Parliament was formed. This new Scottish Government was empowered with a higher level of administrative autonomy and hence, an ability to pursue its own economic and industrial policies in the region. Top government officials, such as Donald Dewar, the first First Minister of the Scottish Parliament (former Scottish Secretary), and Henry McLeish, the Minister for Enterprise and Lifelong Learning, were supportive of the basic principles of the cluster strategy. In 2000, the government published a document in relation to its new economic framework, namely *The Way Forward: Framework for Economic Development in Scotland* (FEDS). The importance of clusters was acknowledged inside the document. In Chapter 4 of the report it was written:

> *'The approach to economic sectors or other economic groupings is equally important to the framework…The benefit of clusters, or the geographical agglomeration of enterprises that have important linkages at some—if not all—stages of the production process from the initial idea to the final marketing of the product, have long been recognised.'* (Scottish Executive, 2000, p.31)

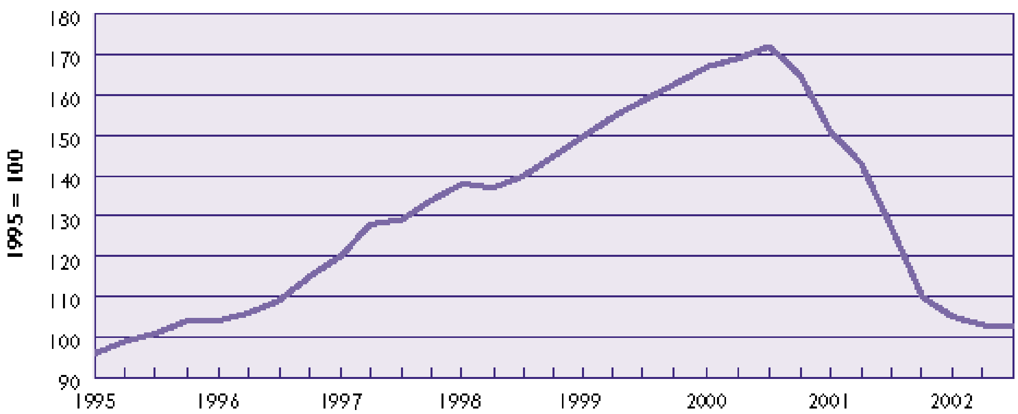
Subsequently, the cluster strategy continued implementation as originally planned. Since the opening of the Alba Campus in 1998, Cadence set up an operation with over 100 engineers working on the campus. Besides, a number of design intensive ICT companies moved into its Design Centre, including Intel, Atmel, Epson, Motorola, Verilab, Sagantec, Micrel, etc. (Alba Centre, 2002) However, the number of ICT companies attracted to the Alba campus was smaller than expected. Most of these ICT companies were small to medium sized and they mainly carried out non-core/peripheral R&D activities in the campus. Nevertheless, a number of new programmes were started out to strengthen the cluster strategy in early 2000. These included **Microelectronics Test Centre (MTC)** which aimed at providing test facilities to the microelectronic companies, **Scottish Embedded Software Centre (SESC)** which had as objective to provide up-to-date embedded software techniques and knowledge to ICT companies and a web-based programme **Talentscotland.com** which served the purpose of attracting overseas R&D talents to work in Scotland.

Moreover, new initiatives have been introduce to provide support for the 'new/extended' cluster strategy which also emphasised on new business development. For instance, **Technology Venture Scotland (TVS)** was launched in 2000. As we have seen, its main task was to improve the commercialisation activities in Scotland by looking for a common ground to bridge the gap between industry and university. Moreover, in order to encourage the development of entrepreneurship at higher education institutions, another initiative, **Scottish Institute for Enterprise (SIE)**, was introduced in the same year to provide business education and training to academic entrepreneurs so as to equip them with the necessary business skills for new company formation and development. These new initiatives, together with the funding programmes such as RSA, SMART, SPUR, SE/RSE Enterprise Fellowships and Proof of Concept Funds which have already been in place, helped increase the number of university spin-outs significantly. These included MicroEmissive Display, Photonic Materials and Intense Photonic. The success of these university spin-outs encouraged the Scottish government to pursue a policy to give further support to the commercialisation of technology from the higher education sector.

**2. ICT industrial setback since 2001**

Just when the constituency building process of the ICT cluster was beginning to acquire momentum, the Scottish ICT sector suffered a serious industrial setback caused by the worldwide economic recession after the burst of the dot.com bubble and the 9/11 terrorist attack to the US. As a consequence, the Scottish ICT sector suffered a diminishing demand for its ICT products, especially with regard to its electronic hardware and telecommunication equipment in both domestic and overseas markets. According to a survey conducted by Scotland IS, Scottish Enterprise and the Royal Bank of Scotland, 68% of companies in the ICT sector described the setback as '*the most dramatic downturn the industry has ever witnessed*'. The surveyed firms also reported a decrease in revenue of up to 31% within six months of 2001. (Scottish Technology Industry Monitor, 2002) Figure 4.3 also showed the rapid decline in output of the Scottish ICT sector since the setback. In 2002, the output fell over 70% to a figure of only 3% above its 1995 level.[18] (Scottish Executive, 2003a)

Figure 4.3 Scottish index of electrical and instrument engineering output, 1995-2002 Q3 (Source: Scottish Economic Statistics, 2003).




The downturn in the global ICT industry further hastened the contraction of inward investors. For instance, Motorola closed its mobile phone manufacturing plant in Bathgate in 2001, leading to the loss of 3,100 jobs. Compaq in 2002 closed its manufacturing plant in Renfrewshire and relocated to the Czech Republic. Displacement in technology, such as

[18] For instance, in 2001, the export of office machinery products fell by 15.9% to £5.8 billion, representing over £1 billion lost in Scottish export sales in 2001. Exports for radio/TV/communications equipment dropped 19.5%, which was the biggest drop in the manufacturing sector (Scottish Executive, 2002a).

the change from VCRs to DVDs, also led to the closure of the Taiwanese company Chunghwa Picture Tubes's Lanarkshire operation with a loss of 600 jobs in 2002. As Table 4.11 shows, the job loss in the Scottish ICT sector was at its most severe after the industrial setback.

Table 4.11 Examples of job cuts in the Scottish ICT sector from 2001- 1Q of 2003 (Source: The Scotsman, Scotland on Sunday, 2001-2003).

| Date | Company | No of jobs cut |
|---|---|---:|
| Feb 01 | Compaq, Renfrewshire | 860 jobs |
| April 01 | Motorola, Bathgate | 3,100 jobs |
| Aug 01 | NEC, Livingston | 600 jobs |
| Nov 01 | Rolls Royce, Hillington | 440 jobs |
| July 02 | Hewlett Packard (Compaq), Erskine | 650 jobs |
| Sept 02 | Inventec, Hillington and Inchinnan | 600 jobs |
| Nov 02 | Chunghwa, Mossend | 590 jobs |
| Jan 03 | Fullarton Computers, Gourock | 500 jobs |
| April 03 | Motorola, South Queensferry | 600 jobs |

### 3. Governance problems of the ICT cluster

The industrial setback not only wiped out the small success generated by the cluster strategy, but also created an impression in the public that the cluster strategy was a failure. This put on pressure on the Scottish Enterprise cluster team in charge of the strategy. First, the cluster strategy was faced with a reduction of human and financial resources. Instead of providing more political support to strengthen the clusters during the hard times, in 2002, Scottish Enterprise made a number of experts in the cluster team redundant. In addition, the budget for the ICT cluster (including microelectronics, optoelectronics and telecommunication technologies) was reduced from £5.2 million a year to £10 million for three years. One leader of the cluster team talked about the effect of this on their work:

> *'With the reduced budget and reduced team, we have to think very hard which project should we sponsor would have biggest impact. We achieved a lot when having a very wide target with a lot of money. People may see less impact if our team is small and the budget is tighter.'*

Second, the diminishing emphasis by Scottish Enterprise on the cluster strategy was also evidenced by the fact that Scottish Enterprise did not formally talk about 'clusters' anymore. The official webpage for clusters was removed in 2002 and could no longer be found on Scottish Enterprise's website. Due to the budget cut, Scottish Enterprise was unable to do as much as before to promote and strengthen the clusters. Many stakeholders of the cluster saw the ease off in cluster activities, and interpreted it as a sign of cluster decline or death. One interviewee who is a Director of an ICT research institute expressed her views as follows:

> *'It has caused high degree of concern in the industry about the commitment or not of Scottish Enterprise to the electronic sector...And at the time we've seen a lot of redundancy and closure in manufacturing, they haven't had the courage to stick with their policy which is to move up the value chain to the design, so they are scrapping support at the point when in fact they should be putting in more.'*

At this point, it seemed that the ICT cluster was losing its direction and growth momentum. It could be partly attributed to the troubles in relation to its formal and informal governance. For the former, the departure of cluster champions such as Bob Downes and Crawford Beveridge left the cluster strategy without top level leadership and direction in the government. Meanwhile, the members of the cluster team mainly viewed their role as being 'facilitators', rather than leaders. In the words of one of the leaders of the ICT cluster team:

> *'We are something like custodian of the cluster, we look after, we try to grow, we try to do what the community wants…they need and we deliver.'*

It may be argued that a cluster should be driven by industry. Indeed, once the cluster structure has taken roots, the cluster should become self-sustaining from the industry side. However, in Scotland's case, the ICT cluster was left largely unattended before it reached a self-sustaining phase, something of questionable wisdom and most likely to affect its future growth potential.

Besides, the industry members did not think Scottish Enterprise had sufficient credibility to lead the clusters. This impression was reinforced by allegations about Scottish Enterprise's mismanagement reported in newspapers from time to time. For example, in February 2003, a series of news articles revealed a number of failures and shortcomings at Scottish Enterprise. The reports revealed evidence of Scotland Enterprise's careless management in funding operations, failures in the handling of flagship projects and in cases of missed performance targets etc. (The Scotsman, 28 February, 2003) An interviewee who is a

Director of a large overseas ICT company expressed his concern over Scottish Enterprise's leadership as follows:

> *'I would say that there's quite a big worry in the press over last month or two about the way that Scottish Enterprise uses its funding… I don't really know whether these allegation are really true or not…I have seen some allegations of inefficiency and things like incompetence about having missed out on opportunities for grants because Scottish Enterprise didn't apply, how well a central government is able to organise some of these things [cluster building], in particular, if it is true?'*

Newspapers heavily criticised Scottish Enterprise and this contributed to the resignation of Scottish Enterprise's Chief Executive, Robert Crawford in June 2003.

In addition to the troubles in the formal governance, the cluster's informal governance mechanism also began to fall apart. As mentioned earlier, Scottish Enterprise set up the Scottish Electronic Forum (SEF) in the hope of developing a cluster community to provide informal governance to the ICT cluster. However, the Forum did not work out as Scottish Enterprise planned. The Forum was very much dominated by large foreign ICT companies such as IBM, Compaq and Motorola, while the small indigenous companies felt that they were being 'crowded out' from it. Research by Molina and Kinder (2001) also revealed that small indigenous companies saw SEF mainly worked for the short-term benefit of the inward investors. The inability of SEF to generate consensus among the large and small ICT companies led to its gradual running out of momentum.

**4. Sit back and re-align the constituency**

In the midst of the ICT industrial setback and the struggling phase of the ICT cluster, in 2001, the Scottish Executive formally announced a new strategy for economic development, namely *A Smart, Successful Scotland,* which was based on the economic framework set out in FEDS. The official document for the strategy clearly articulated the need for Scotland to advance to the knowledge economy. Three broad routes were set out for Scottish Enterprise to make this advance a reality. They were:

- Growing businesses—supporting innovation and entrepreneurship in new companies and helping existing companies to develop further.
- Global connections—encouraging Scottish companies to increase their involvement in global markets, and attracting people to live and work in Scotland.

- Skills and learning—helping people to get into jobs and ensuring that businesses have access to the skills and expertise they need.

The strategy emphasised the need to support **industrial sectors** as being one of the means to grow businesses. In page 11 of the official publication *A Smart Successful Scotland*, it was written:

> *'We need to raise our productivity in all sectors, including manufacturing, building on strengths whilst helping address structural changes taking place in the economy…'* (Scottish Executive, 2001, p.11)

Again, the government's commitment to continue to offer support to the cluster strategy was shown. The publication not only acknowledged the past contributions of the cluster strategy, such as improving the interaction between industry and the academic community, generating essential intellectual property, encouraging learning, training and development in the targeted industrial sectors, but it also re-affirmed that the cluster strategy was compatible and conducive to other strategic themes required for growing businesses such as entrepreneurial dynamism and creativity, the creation of more e-businesses and the further commercialisation of research, all of which would hopefully eventually lead to **global success in key sectors**.

A *Smart Successful Scotland* also empowered Scottish Enterprise to support the development of clusters. It states: '*in key clusters the [Scottish Enterprise] Network can foster growth and improvement in productivity*' (Scottish Executive, 2001, p.11). Subsequently, a number of activities were announced to realise the Smart Successful Scotland strategy, many of which also helped to put the ICT cluster back into shape. Besides, specific indicators for measuring the progress and the outcomes of each strategic theme in the Smart, Successful Scotland plan were made to ensure the strategy was moving on the right track.[19] In this way, the continuous growth of the ICT cluster and general technology development in Scotland can also be checked and carefully monitored. Table 4.12 outlined the operation plan of the *Smart, Successful Scotland Strategy* for 2003/4. Many of the activities set out in this operation plan helped re-align the troubled constituency building process of the ICT cluster.

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[19] In 2002, the Scottish Executive published *Measuring Scotland's Progress towards a Smart, Successful Scotland*. The intended outcomes of each strategic theme are being set out and benchmarked in conjunction with OECD standards. (Scottish Executive, 2002)

Table 4.12 Key programmes of the Smart Successful Scotland strategy which complement the ICT cluster strategy (Source: Scottish Enterprise operating plan 03/04).

| | *Key strategies* | *Strategic priorities* | *Activities complementary to ICT cluster strategy* |
|---|---|---|---|
| **Smart Successful Scotland** | **Growing businesses** | Entrepreneurial Dynamism and Creativity | Co-investment Fund<br>Business Gateway |
| | | More e-business | Encourage organisations to expand their use of e-business |
| | | Commercialisation of Research and Technology | Intermediary Technology Institutes |
| | | Global success in key sectors | Continue support to ICT clusters |
| | **Global connection** | Digital connectivity | Enlarge broadband coverage in Scotland |
| | | Involvement in global market | Encourage Scottish ICT exports |
| | | Globally attractive location | Attract ICT companies to locate in Scotland |
| | | Choosing to work and live in Scotland | Talent Scotland Scheme |
| | **Skills and Learning** | Improving the operation of the Scottish labour market | Strengthen education & training programme |
| | | The best start for all our young people | High Technology Talent Board in Scotland (enhance students' interest in science subjects) |
| | | Narrowing the gap in unemployment | West Lothian Strategic Action Plan (re-skilling for redundancy employees) |
| | | Improved demand for high quality in-work training | Training programmes for specific industrial sectors |

As the above table shows, many strategic themes set out in the Smart Successful Scotland strategy mutually reinforce the cluster strategy. For instance, initiatives like Co-Investment Fund, Business Gateway and Intermediary Technology Institutes were directly related to and aimed at addressing some of the deficits of the original cluster strategy. Besides, actions to attract inward investors and overseas technology talents to locate in Scotland also helped the ICT cluster to build up a critical mass which was very much needed at this stage. Programmes like provision of training, re-skilling and science education contributed to strengthen the present and future workforce of the ICT industry. All these efforts derive from a holistic economic development strategy that aimed to generate a virtuous cycle and strengthen the ICT cluster in a number of different aspects. The further strengthening of the ICT cluster strategy could be achieved through the exploitation of synergies between the various policy programmes set out in the Smart Successful Scotland strategy.

Table 4.13 Overview of the alignment conditions of the Scottish ICT cluster at its downturn phase

| **State of alignment of the Scottish ICT Cluster at the end of downturn phase** |
|---|
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• The Scottish Parliament came to the scene in 1999 and declared its support to the cluster strategy. At the beginning of this stage, the cluster strategy started to generate positive results, such as the setting up of design centres by MNCs in Scotland and the increasing number of university spin-outs, though the number was unable to match the original projection.<br>• The ICT industrial setback further hastened the relocation trend of ICT manufacturing plants. The huge job loss in Scotland cast a shadow over the cluster strategy. The inability of the cluster strategy to meet its goal made people believe that it was a failure.<br>• The inability of the cluster strategy to generate impressive results also put pressure on Scottish Enterprise. Resources given to the ICT cluster, in terms of human and financial resources, declined and affected the growth of the cluster strategy. No more new initiative was introduced in the downturn phase in 2002.<br>• Scottish Enterprise tried to play down the cluster strategy by removing the cluster website and did not use the word 'cluster'. This further confirmed in the public an impression that the government had retracted from the 'cluster' policies.<br>• The conflict of interests between the large and small ICT companies divided the cluster community and the failure of the Scottish Electronic Forum led to the weakening of market governance and industrial support to the Scottish ICT cluster.<br>• The ICT cluster seemed to loose direction at this stage due to the departure of the two main cluster champions. Fortunately, at the end of this stage, a new strategy, namely the 'Smart, Successful Scotland' strategy which supported the idea of clustering was announced. This strategy was going to be carried by the Scottish Executive, an organisation which was empowered with higher autonomy and authority after the |

devolution.

**(II) Nature and Maturity of the Technology**

- The content of this dimension remained very much the same as the previous phase. That is to focus on upgrading Scotland's technological capability from mature, low value added manufacturing activities to knowledge intensive, high value added design and production activities.
- The migration of ICT manufacturing plants from Scotland to low cost economies at this phase proved that the low value added production activities in Scotland was unsustainable in the long term. The phase out of technology also hurt Scotland's ICT industry due to its lack of technological capabilities to catch up and innovate.
- The export oriented nature and small local market made the Scottish ICT sector vulnerable to external impacts. In the near term, these problems could not be solved. At the end of this phase, the government sought to upgrade Scotland's technological capabilities through increasing commercialisation of research from universities. However, most ICT technologies developed at universities were premature for commercial use.

**Alignment (1) Governance**

- The organisation of the ICT cluster was weakened due to the departure of its cluster champions and the subsequent cut back of human and financial resources. Scottish Enterprise suffered from a credibility crisis due to allegations concerning a handful of mis-management cases. The chief executive of SE Robert Crawford who supported the cluster strategy resigned at the end of this stage.
- New Scottish government brought Scottish Executive onto the scene. It initiated the new strategy 'Smart, Successful Scotland' which seemed to complement the cluster strategy. This meant that the cluster team could gain support from the new Scottish government, which has greater power and more resources to carry out re-alignment programmes.
- Informal governance mechanism (Scottish Electronic Forum) developed by Scottish Enterprise did not work out properly and the ICT cluster gradually lost its market support. It implied that Scottish Enterprise had to re-establish a new informal governance mechanism should it want to continue the cluster strategy
- Hit by the industrial setback, the cluster action plan was unable to meet its targets and therefore Scottish Enterprise began to de-emphasise the cluster strategy. However, the re-emphasis of 'clustering' by the new Scottish government implied that new actions and resources had to be put into to the ICT cluster to re-align the cluster building plan.

**Alignment (2) Nature of Target Problem**

- The timing for launching the cluster strategy was bad. While the cluster strategy began to generate small effects, these have been offset by the industrial setback. The cluster strategy was loosing support from the public due its inability to save the declining Scottish ICT industry.

- The Scottish ICT cluster building process was constrained by its structural problems. For instance, the number of ICT companies was small, and it was difficult to identify complementarities and encourage collaboration among them due to the shortage of a critical mass. It became one of the greatest impediments for building an ICT cluster.
- The management of the ICT cluster by Scottish Enterprise was fraught with problems, such as lack of resources, credibility, commitment, etc. To re-launch the cluster strategy, the Scottish government would have to solve its governance problems.
- Despite the new Scottish government intended to re-build the knowledge based ICT cluster based on the commercialisation of university research, it would be difficult as the research at universities might be too theoretical to apply on commercial products and it also huge amount of resources are required to develop university spin-off companies.
- In short, the largest challenge of the ICT cluster was to come out from its downturn phase and to embark on a number of re-alignment processes to get the ICT cluster back on track.

**Alignment (3) Target Constituents' Perceptions and Pursuits**

- Since the ICT cluster was loosing popularity, the Scottish government had to convince a large number of target constituents to lend their support to the ICT cluster, these target constituents included large and small ICT companies, universities, financial sectors, etc.
- In an attempt to solve the problem of lack of a critical mass, the Scottish government has to recruit more ICT companies from abroad to locate their design centres in Scotland, and to help to form more indigenous ICT companies.
- Since one of the identified ways of generating companies was to create university spin-outs, the government must persuade universities in Scotland to pursue more commercialisation activities and provide them with financial assistance.
- To support the growth of indigenous ICT companies, the Scottish government must get more involvement from the financial community, in particular the angel funders and VCs in the ICT cluster
- Owing to the decreasing funding support to the ICT cluster from the Scottish government, the cluster team needed to gain extra support from elsewhere. This implied that the cluster must involve new actors in the UK and even from the EU.

**Alignment (4) Interacting Technologies/Constituencies**

- At this stage, the trend of re-locating ICT manufacturing plants from Scotland to low-cost countries has become intensified. Some countries like China also provide cluster environment for overseas ICT companies. This implied that the Scottish ICT cluster was in competition with other clusters in different countries.

- Scottish Enterprise has developed eight clusters and they competed with each other for resources (Scottish Enterprise only had a £450 million fixed budget each year).
- The new 'Smart, Successful Scotland' strategy has very wide objectives, including stimulating new business development and creating more e-businesses. This might mean competition for resources for cluster building.
- Similarly to the previous stage, inside the ICT cluster, the range of technologies was very wide and there would be interactions with technological development taking place elsewhere, such as e-businesses and optoelectronics.

### 4.2.4 Period 4—Evolution of the ICT cluster (2004-present)

**Re-alignment of the constituency building process of the Scottish ICT cluster**

**1. A gradual change of the industry's mindset**

Despite the industrial setback caused damages to the Scottish ICT cluster, it did also contribute to another thing—a gradual change of mindset among the cluster stakeholders. The setback clearly demonstrated to many ICT companies how important innovation and technology development could be to their businesses and hence inspired them to support the cluster activities again. One interviewee who is the Chairman of an ICT trade association said:

> *'A number of small companies in the supply chain in Scotland had it too easy because their major plants were on the doorstep and they simply were told what to do but they didn't bring innovation, they didn't bring new development to the floor. Now that the manufacturing plants have moved overseas, there is much more of a need for those companies to work harder at innovation and harder at marketing themselves …'*

Such mindset change was evidenced through the more proactive participation in two new ICT trade organisations, namely Electronics Scotland (ES) and Scottish Optoelectronic Association (SOA) after the industrial downturn. Originally set up in 1999 and 1994 respectively, these two organisations have been strengthened in recent years through the participation of key industry members and related organisations in the two technological fields. As an ICT cluster team leader spoke about the SOA:

> *'We have an association which includes around 90% of the membership, in fact, probably it's 100% of the opto companies that belong to the Scottish Optoelectronic Association'*

These organisations formed the backbone of the new ICT community and they began to work with Scottish Enterprise to re-build the ICT cluster. While the previous phase of the ICT cluster was driven by Scottish Enterprise, in this new phase the ICT industry and Scottish Enterprise have worked together to draw up the action plans. This means that industry can tell the public body what they want – and not the other way round! These trade associations meet regularly to examine different research topics about their industries and check the progress of the cluster action plan, while making suggestions for changes if they think they are necessary. In this way, the trade associations take up the role of helping to monitor, evaluate and promote the activities outlined in the cluster plan. As a leader of the ICT cluster team stated:

> *'If you have a cluster community who are responsive and helpful, they often say, hang on, look at these things, quite like what exactly is happening in California, learn from that! We learn from their experience, their own business and their own academic circle, we do this on a very regular basis...'*

**2. Re-alignment of the ICT cluster's 'target problems'**

**a. A review of the constituency building process of the ICT cluster**

As already stated, the industrial setback led to major changes in the structure of the ICT sector, with old players gone and new players arriving to the scene. The goals and targets set in 1999 were no longer suitable for the new structure of the ICT sector. Therefore, the initial step with regard to the re-alignment effort of the ICT cluster team was to carry out a comprehensive review on the constituency building process of the ICT cluster and examine what had been achieved over the years.

In 2004, Scottish Enterprise conducted a thorough review of the ICT cluster. The review acknowledged the achievement of the cluster strategy since its inception in 1999. According to Scottish Enterprise's report published in October 2004, namely the *Micro & Opto*

*Electronics Cluster Review and Strategy*, the major achievements of the ICT cluster could be summarised in Table 4.14:

Table 4.14 Major achievements of the Scottish ICT cluster since its inception (source: Micro & Opto Electronics Cluster Review and Strategy, Scottish Enterprise, 2004, p.1)

- The Institute for System Level Integration (ISLI) now has the largest dedicated System on Chip centre in the UK. It launched the world's first MSc in System Level Integration in 1999 and its leading Engineering Doctorate in 2000.
- A complete Scottish supply chain for diode pumped solid state lasers for defense and other applications is now in place - 5 years ahead of schedule
- The industry celebrated its first listing in four years with the successful Initial Public Offering for Wolfson Microelectronics.
- The Alba Centre initiative has changed the global perception of Scotland's design industry. The number of indigenous design companies has more than doubled, and the number of designers engaged in research and development is nearly 2000 - a rise of nearly two thirds.
- Over a third of all Enterprise Fellowships have been awarded in Microelectronics, Optoelectronics and Communications Technologies. Over £5.7m of Proof of Concept funding has been awarded to Proof of Concept projects in these areas.
- Over 22,000 people have registered with TalentScotland.com, and around 250 people have found jobs through the site.
- More than £4m was invested in Optocap to support optoelectronics encapsulation requirements from industry and academia.
- The Scottish Microelectronics Centre was launched in 2000 with £8m invested by a partnership of Scottish Enterprise, the University of Edinburgh and Scottish Enterprise Edinburgh & Lothian.

Besides, the review not only helped generate an understanding of the present composition and characteristics of the ICT sector after industrial re-structuring, but, more importantly, it collected a lot of feedback from the cluster players who pinpointed a number of deficiencies in the past cluster strategy. Their opinions proved useful as the Scottish Enterprise cluster team could focus their efforts on correcting the problems and hence, attempt to strengthen the ICT cluster. The suggestions from the cluster players to improve the cluster strategy included:

- Greater emphasis on indigenous company growth
- Need to maximise Scotland's intellectual property portfolio
- Development of complementary business skills, such as marketing and business management
- Strongly link manufacturing, processing and the supply base with innovation (Scottish Enterprise, 2004, p.7).

With all the information gathered from the ICT cluster review, Scottish Enterprise set forth their 'revised' cluster strategy for the ICT sector over the next five years (2005-2009). The goals for the new phase of the cluster strategy were clearly articulated in *Micro & Opto Electronics Cluster Review & Strategy* (published in 2004) as follows:

> *'To grow competitive and sustainable industries utilising microelectronics and optoelectronics technologies based on innovation, which enhance and exploit the research, design and development capabilities of businesses, research institutes and universities in Scotland.'* (Scottish Enterprise, 2004, p.7)

**c. Re-defining targets and strategies**

Based on the review results, Scottish Enterprise began to re-define the ICT cluster's targets according to the most up-to-date situations. As two leaders of the cluster team said:

> *'So basically we had to look at the current picture and adapt the plan to make it make sense. We want to have 5,000 design jobs in Scotland by 2004, its pretty clear that in the current situation we were harassing jobs instead of creating jobs in Scotland. It has been happening all over the world, so that's silly to follow the plan as it was. That's happened in all areas and all people looked at the plan and say, that is naïve, that's the reality, so we have to change it…'*

> *'It must be a moving strategy, it must be a moving action plan because the world doesn't stay still. The view of the world we took in 98 is very different. If we were starting again today, it would be a very different strategy…'*

As a result, new measurable targets and strategies were set for the ICT cluster (see Table 4.15). In addition, opportunities for new ICT markets were identified. Rather than focusing on the traditional computer electronics industry, Scottish Enterprise encouraged Scottish ICT companies to tap into the emerging market areas in telecommunications, car electronics, media electronics, defence and renewable energy.

Table 4.15 Key targets and strategies for the ICT cluster over the period 2005-2009 (Source: Micro & Opto Electronics Cluster Review and Strategy, Scottish Enterprise, 2004, p.8).

| **Targets for the Scottish ICT cluster over the period 2005-2009** |
|---|
| • Create an additional £186 million of extra assets for the Scottish economy by outperforming it in terms of growth of value added per employee from £44,000 to £47,000 per annum<br>• Increase the research, design, and development of staff levels from 10.2% to 15% as a percentage of total employment<br>• Increase business research and development expenditure from 8.3% to 10% as a percentage of total revenues |
| **Strategies for the Sc ottish ICT cluster over the period 2005-2009** |
| • Build critical mass in key market areas<br>• Strengthen local and international networks<br>• Develop a workforce for the future<br>• Increase global competitiveness<br>• Promote company creation, growth and sustainability in Scotland |

As the above table shows, the new strategies and targets for the new phase of the ICT cluster were more prudent when compared to the previous one, as well as being more in line with the present situation in Scotland. The cluster team also forfeited the use of the number of jobs created as the indictor for measuring the level of success of the ICT cluster. Rather, the new focus is on the value augmentation of the industry. The ICT cluster strategy papers have been published, allowing the wider public access to them via the internet. This approach is very different from the previous one as previous strategy papers were only circulated among a group of immediate stakeholders of the ICT cluster.

**c. New course of actions**

Having recognised that the early phase of the ICT cluster strategy was undermined by the structural problems of the sector, and particularly by the lack of a critical mass of ICT companies, in the new phase of the cluster development the ICT cluster team decided to focus their re-alignment efforts in tackling this issue by creating more ICT companies. After the industrial setback, activities for attracting inward investors have slowed down, while more emphasis has been put on supporting the indigenous ICT companies. As a leader of the ICT cluster team said:

*'I think we need to focus on indigenous technology companies, they grow and do very, very well, for example, the design houses. So we keep the focus on design intellectual property because it's easy to make that technology play in the global market and keep you on top.'*

Other members of the ICT cluster team added:

*'A lot of [effort] that was chasing the inward investment jobs has changed into support for some of the key cluster activities…'*

*'The approaches are changing, we're pretty much more focused on existing businesses and on the opportunity for developing the technology IP in Scotland, and not on major inward investment in Scotland...'*

The new programmes launched by the Scottish Government in the new phase of cluster development are summarised in the following table:

Table 4.16 New policy initiatives pursued by the Scottish government to support the development of the knowledge-based ICT cluster.

| | |
|---|---|
| ***Commercialisation:*** | |
| **Intermediary Technology Institutes (ITIs)** | In 2003, three Intermediary Technology Institutes (life sciences, communication technology and digital media, and energy) were set up to manage market foresight activities and commission research to universities. Each institute has been offered a funding of £15 million per annum and a total budget of £450 million has been allocated for three ITIs over a period of the next 10 years. ITI adopts a market-pull approach and provides funding to develop pre-competitive technology that may yield benefits to a wide range of companies. |
| **SCORE** | Introduced in 2004, SCORE is a programme providing financial support to Scottish SMEs and HEI partnerships of up to 50% of eligible project costs, with a maximum grant of £35,000 per project in order to undertake an R&D project. |
| **SEEKIT** | Introduced in 2005, SEEKIT is a scheme that provides support for a wide range of knowledge transfer/outreach activities and has the aim of improving HEI's ability to work effectively with Scottish SMEs. |
| ***Funding schemes:*** | |

| | |
|---|---|
| **R&D Plus (R&D$^{P}$)** | Introduced in 2004, this is the first scheme of its kind in the UK to support R&D in larger companies. The scheme provides discretionary grants to large businesses to support R&D of up to 25% of the total costs. The funding considerations include the strategic importance of the R&D and creation of R&D jobs. |
| **Small Company Innovation Scheme (SCIS)** | Introduced in 2003, SCIS provides a discretionary grant to small and medium-sized companies to support R&D of up to £25k per project. |
| **Scottish Co-Investment Fund (SCIF)** | Introduced in 2003, Scottish Enterprise committed £20m to form a partnership with private sector investors to co-invest in early stage high growth companies. The amount available per company can rise to £500k, within a deal size ceiling of £2m. |
| **Industrial Fellowships (IF)** | Introduced in 2004, operating similarly to the Enterprise Fellowships, these have the aim of attracting potential entrepreneurs from the private sector and supporting them to form new technology companies. |
| ***Human Resources:*** | |
| **Fresh Talent Scheme (FTS)** | Launched in 2005 with the aim of increasing the inward flow of talent to Scotland. The scheme enables foreign graduates from Scottish universities to stay and work in Scotland for two years after completing their studies without the need for a work permit. |

## 3. Re-alignment efforts in action

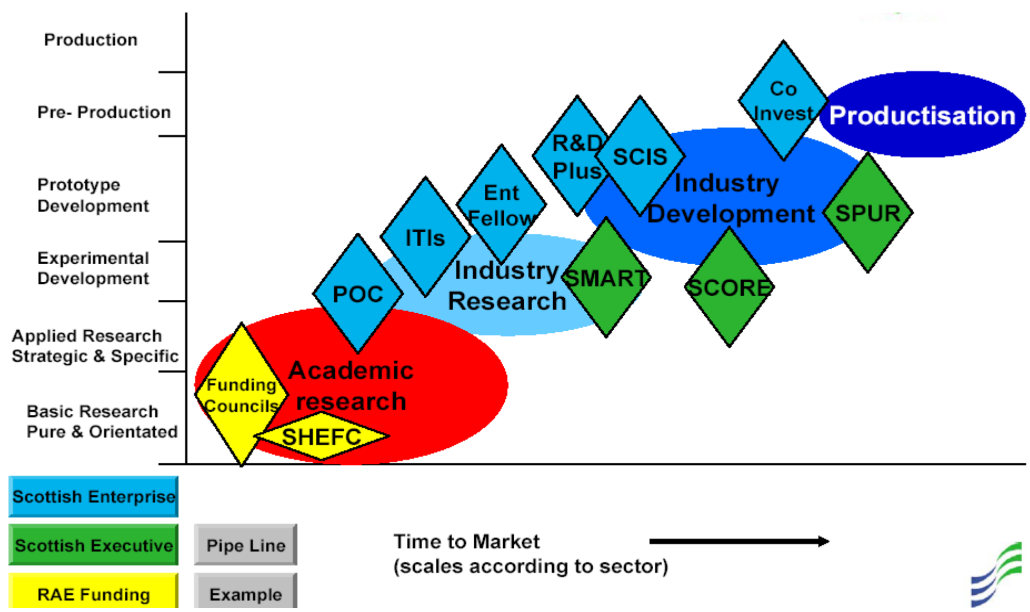
### a. Filling the funding gaps

In order to support the growth of new ICT businesses, a number of actions applied in the previous phase of the cluster strategy, such as the Proof of Concept Funds and the SE/RSE Enterprise Fellowships have continued. In addition to the above, Scottish Enterprise also launched new funding programmes to fill the funding gaps in the company development pipelines. For instance, having recognised that the past approach had been too narrowly focused on university spin-outs, new **Industrial Fellowships** were introduced in 2003/4. This aims at attracting potential entrepreneurs from the private sector, especially those from large corporations, to form spin out companies.

In addition, a new **Co-Investment Fund** was launched in 2004 with the hope of easing the problem of venture capitalists who have been unwilling to invest in Scottish start up companies. Operating in partnership with private sector investors such as venture capital funds, business angels and business angel syndicates, the scheme provides funding to co-invest alongside private sector investors on equal terms and to support early stage companies with up to £500,000 per deal. The Fund helps boost the confidence of the private sector investors in Scottish companies and increases the amount of risk money available for start up and early stage Scottish companies.

Together with other existing funding schemes operated by other organisations such as the Scottish Executive and the Scottish Higher Education Funding Council, most of the gaps in the pipeline from commercialisation to productisation of technology have been filled up. Figure 4.4 shows all the funding schemes available along the commercialisation pipeline.

Figure 4.4 Scottish Government's funding schemes along the commercialisation pipeline (Source: Scottish Enterprise Innovation Support Pipeline, McCoull, 2005)




## b. Building local user-producer networks

The problem with regard to the weak user-producer networks among Scottish ICT companies is more difficult to solve, at least in the short term, but attempts have been made to seek solutions to this problem. The Scottish Enterprise cluster team set out a strategy to encourage the complete development of the Scottish supply chain. For example, a supply chain of such a kind has been developed for BAE Systems's diode pumped solid state lasers for defence and other applications. Scottish based companies are responsible for the product design, component/materials design, packaging, system integration and building before selling to the market place. The Technical Director of BAE Systems talked about the use of local suppliers:

> *'We try to encourage our supply base, and we have programmes that encourage our supply base to be more efficient, both for our benefit and for their benefit, so we have an excellent supplier program.'*

By recognising that not only can suppliers gain benefits from their customers, but that customers can also gain valuable support from their local supply companies through their advanced technological capability, BAE Systems could become an example of demonstrating to other Scottish ICT companies how a win-win relationship at work can be achieved.

**c. Facilitating the industry-university linkages**

To tackle the problems concerning the weak industry-university linkages in the cluster, the Scottish government has started to encourage more collaboration between Scottish companies and the higher education institutions by offering financial incentives. For example, through the **SCORE programme**, Scottish SMEs can obtain financial sponsorship for their research projects, jointly developed with the universities or research institutes. The Government also introduced the **SEEKIT programme** in 2005, which also induces incentives for the HEI side to transfer their technologies to local SMEs. These two programmes aim to motivate the two key groups of players in the cluster to collaborate and develop knowledge relationships with each other.

**d. A market-pull approach for commercialisation activities**

One of the reasons that caused the low level of commercialisation activities in Scotland was the technology push approach adopted in the previous phase of the cluster strategy. In addition, universities failed to produce technology research that met the needs of industry or that could be used by industry. In order to improve the efficiency of the commercialisation process and capitalise on the strong research capabilities of Scottish universities, Scottish Enterprise set up three **Intermediate Technology Institutes (ITI)** in Energy, Life Sciences and Communications Technology and Digital Media. Each ITI manages a sophisticated on-going market foresight process with key industrial players and has the target of identifying future global market opportunities for the respective technology area. After defining the knowledge need, ITI may pursue such opportunities by commissioning the research to universities in Scotland or worldwide. In this way, ITI supports the development of market focussed, pre-competitive technology in high growth businesses that utilise the existing research capability. It is worth noting that ITI concentrates on a 'market driven' approach and such intent is clearly articulated in its leaflet as follows:

> *'It is essential that this research be commercially driven with a focus on the application of technology being paramount. The commercial drive not only identifies those areas with maximum potential economic benefit to Scotland but also builds the necessary strong linkages to the global market in terms of customers and partnerships. The essential component of the Intermediary Institutes is that they are demand, not supply driven.'* (Scottish Enterprise, 2003a)

In 2004, the ITI of Communication Technology and Digital media announced its first R&D programme in Game-Based learning (Scottish Enterprise, 2004).

**e. Demonstrating long term commitment from the government**

Another remarkable fact about the ITI is that it demonstrated the Scottish Government's long term commitment to support technology development in Scotland. For the first time, Scottish Enterprise announced its determination to support a programme for a ten year period. To quote the words in Scottish Enterprise's *Operation Plan Summary* of 2003:

> *'Scottish Enterprise recognises that this is a long term programme and intends to commit funding of £450 million over the next ten years'* (Scottish Enterprise, 2003, p. 25).

This may help change the perception of the industry and that of other cluster players about the 'short-termism' approach that the government pursued in the past and so help reduce uncertainty about the government's future direction of supporting technology development in the region.

**4. Improving the governance of the cluster**

In the new strategy paper, it was clearly stated that:

> *'This is a strategy for Scotland and its success will depend on the participation and support of the organisations and companies engaged in the cluster community. Equally important it requires Scottish Enterprise to effectively deploy its own resources cohesively and consistently.'* (Scottish Enterprise, 2004, p.10).

The following efforts were made by Scottish Enterprise to improve its management of the ICT cluster:

**a. Setting small targets and reviewing the mechanism**

In addition to the above, Scottish Enterprise also made substantial efforts to enhance its management of the cluster. First, Scottish Enterprise set up a formal mechanism to monitor the progress of the ICT cluster. For instance, the cluster community formed by members of major trade organisations such as SOA and ES meet every month to discuss key issues in relation to the ICT sector. When smaller targets are set as the milestones for different actions in the plan, an evaluation then takes place every year to check the progress of the plan. One of the ICT cluster team leaders mentioned this:

> *'Every year we have an operating plan. Within that operating plan, we set out several objectives, target milestones and the individual activities, programmes we are going to deliver in a 12 month period, which all tie in the strategy and the vision of the cluster.'*

**b. Consolidation of different initiatives**

In the past, the most often heard complaints were about the lack of consistency of the programmes operating at different Local Enterprise Companies (LEC). This confused the industrial players with regard to what kind of help was available to them. In 2003, Scottish Enterprise set up **Small Business Gateway** (SBG) as a single point of contact for companies seeking support programmes in the region. This also helps to reduce duplication and confusion amongst the companies.

**c. Broadening the ICT cluster and maximising benefits**

One of the efforts made to streamline the operation of the ICT cluster was to merge the microelectronics, optoelectronics and communication technology clusters into one cluster. This not only makes the cluster building effort more focused, but it also enables ICT companies to capitalise on the opportunities for convergence among the three related technologies. One of the ICT cluster team leaders explained:

*'Microelectronics, optoelectronics and communication technologies are all bound together; they are extremely synergic in nature and there are a lot of commonalities between the three…'*

For example, optoelectronics and semiconductors are interlinked and complement each other as components in the semiconductor manufacturing process. A segment of optoelectronic components are manufactured from silicon (the non-silicon materials are known as compound semiconductors) and many optoelectronic devices such as lithography equipment, machine vision making systems and metrology are used in the capital equipment essential to the chip manufacturing process. Since both these technologies are based on similar silicon manufacturing processes, the combination of optoelectronics and semiconductors may bring about the potential to create new companies in Scotland through the utilisation of the existing semiconductor manufacturing technology. As an interviewee from the semiconductor supplier industry said:

*'The way to survive is trying to identify new markets, not necessarily semiconductors, but other markets use and need semiconductor type skills. The obvious one is optoelectronics. Some optoelectronic products are made on semiconductor wafers, but not necessarily silicon, such a thing is called compound semiconductors and traditionally we don't pay much attention to compound semiconductors because the volume is small, but now, as a means of survival, we supply to either compound semiconductors or silicon semiconductors.'*

In addition, both microelectronics and optoelectronics are enabling technologies and have a wide application in different products and industries. For instance, the integration of optic and electronic components or products have huge application potentials, some of which are data processing, defence manufacturing, consumer products, automotive, medical and communications industries, to name but a few. The combined ICT cluster team broadens the scope of its supporting activities and helps companies to tap into the new converging technology markets. This intent is clearly spelled out in the new ICT cluster strategy paper:

*'New emerging markets will require the combination of technologies and this will play to our strengths…'* (Scottish Enterprise, 2004, p.10)

**d. Strengthening the informal governance of the ICT cluster**

As already stated, the industrial setback brought a gradual change of mindset and that made the industry members more motivated to participate in the networking activities, partly because they realised that continuous innovation is of importance to the growth and survival of their businesses. A cluster team leader talked about the evidence of improving motivation among industry players demonstrated in one of their events:

> *'We just held our fifth com tech briefing session, to which we invited every members of the com tech community. We got queries about why we are not included, can we be included, etc and we had a good response. We had 50 companies at our last meeting, the figure has gone from 20 to 50, this is a quarterly event which talks about the community, talks about the activities in that area…'*

In addition to this gradual change of mindset, the two industrial bodies also improved their operations. For example, Electronics Scotland changed the way that Scottish Electronic Forum acted in the past. Rather than narrowly representing the interest of large manufacturing ICT companies, now both large and small ICT companies have a presence in the association[20]. As a Technical Director from a large UK ICT company said:

> *'I persuaded the company recently to become a member because it's changing times, and I think smaller companies around can benefit from our membership to some extent and we can benefit from them…'*

Besides, according to Scottish Enterprise's description, the Scottish Optoelectronic Association (SOA) has almost 100% of the opto companies as members. Since the organisation got the participation from key people from the sectors, smaller companies were encouraged to join and as a cluster team leader said, *'they are pretty influential in terms of persuading the rest of the membership what to do.'*

The active participation of ICT companies in these industry organisations also helped provide favourable and strong informal governance to the renewed ICT cluster. They could voice out their concern about the ICT cluster and these organisations would reflect them to the Scottish Enterprise's cluster team on their behalf. The informal networking opportunities provided by these organisations also helped develop closer relations among different members, thus paving the way for their future formal collaboration.

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[20] As stated on Electronics Scotland's webpage, the Board of ES is made up of senior business leaders from the sector '*representing the interests of multinationals and SMEs alike*'. (Electronic Scotland, 2004)

Table 4.17 Overview of the alignment conditions of the Scottish ICT cluster in its present phase

| Assessment of the state of alignment of the Scottish ICT cluster in its present phase |
| --- |
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• At this stage, the perceptions of market players seemed to be more aligned to the cluster's goal and vision. After the industrial setback, they realised the importance of innovation and adding value to their products. This made them more motivated to participate in the ICT cluster.<br>• After the industrial setback, the goal of the ICT cluster has been modified, new goals were set up to align with the structural changes in the ICT sector and with the Scottish reality.<br>• New actions were put in place with the aim of turning around the deficits of the ICT cluster, some of these being to introduce a market driven approach (ITI), to fill the investment gap (Co-investment funds) and to streamline operations (Small Business Gateway), etc.<br>• New financial resources were added, such as R&D plus, Co-investment funds, ITI, etc. with an aim to bridge the funding gap for new companies in Scotland.<br>• The ICT cluster could leverage on the other programmes set in the Smart, Successful Scotland strategy to gain more resources, such as those for training and export marketing. |
| **(II) Nature and Maturity of the Technology**<br>• The content of this dimension remained very much the same as the previous phase. That is to focus on upgrading Scotland's technological capability from mature, low value added manufacturing activities to knowledge intensive, high value added design and production activities. In this stage however, the approach was to build on Scotland's existing strengths and this meant streamlining the operation of the ICT cluster by merging the microelectronics, optoelectronics and communication technology clusters into one cluster. Thus, Scottish ICT companies have begun to exploit the optoelectronics and microelectronics technologies in the manufacturing process and the integration of the two technologies in ICT components and devices.<br>• Also, new markets are emerging in converging technologies in communications, automotive, renewable energy, defence, security and media devices. Scottish Enterprise encouraged the ICT industry to capture the new opportunities arising from this convergence trend. |
| **Alignment (1) Governance**<br>• The formal governance of the ICT cluster has been strengthened at this phase. Scottish Enterprise has sought to improve the governance of the ICT cluster by conducting a |

comprehensive review and collecting feedback from the industry players.

- The original goal has been modified to keep in line with the present situation. An evaluation mechanism has been set up to review the cluster plan every year, small targets are set as milestones to measure the process. The industry community has cooperated with the government to design the action plan and check its progress.
- Organisationally, microelectronic, optoelectronic and telecommunications have been merged into one cluster, with the aim of exploiting the synergies and collaboration among the three sub-sectors. The Small Business Gateway (SBG) has been introduced to provide one-stop-shop services to industry players. This helped streamline the operation and enhance the efficiency of the ICT cluster.
- Informal governance has been improved by involving larger number of ICT companies, both large and small alike in two industry organisations, namely the Electronic Scotland and Scottish Optoelectronic Association. These two organisations have been influential in uniting the ICT companies and encouraging them to support the new ICT cluster action plan.

**Alignment (2) Nature of Target Problem**

- The structural problems facing the goal of a Scottish knowledge-based ICT cluster are still unsolved. Scotland's ICT industry is still fragmented with a large number of small companies without an industry leader. The local user-producer relationships are weak, Scottish suppliers are uncompetitive due to the high cost structure of the region, while a wide gap still exists between universities and industry.
- Even though the Government has encouraged a local supply chain approach, this was hard to implement as the local market is too small and local suppliers are not competitive in terms of price and technological capabilities.
- The Government has started a large number of new initiatives to carry out the alignment programmes, these tend to require sustained funding in the long run but it was doubtful whether the government could really sustain this type of funding for large area of activities.
- At this stage, the global downturn of the ICT industry began to ease off. Forecast for the total global end market value for electronics is over US$ 1 trillion, providing vast opportunities for ICT companies.

**Alignment (3) Target Constituents' Perceptions and Pursuits**

- The enlargement of the ICT cluster due to the increased number of ICT sub-field technologies and the number of supporting programmes means that new players of the ICT clusters are needed, these include private investors, new suppliers and customers in the opto/micro/techcom fields, new markets, new researchers from the higher education sectors, new technology talents from home and abroad etc.

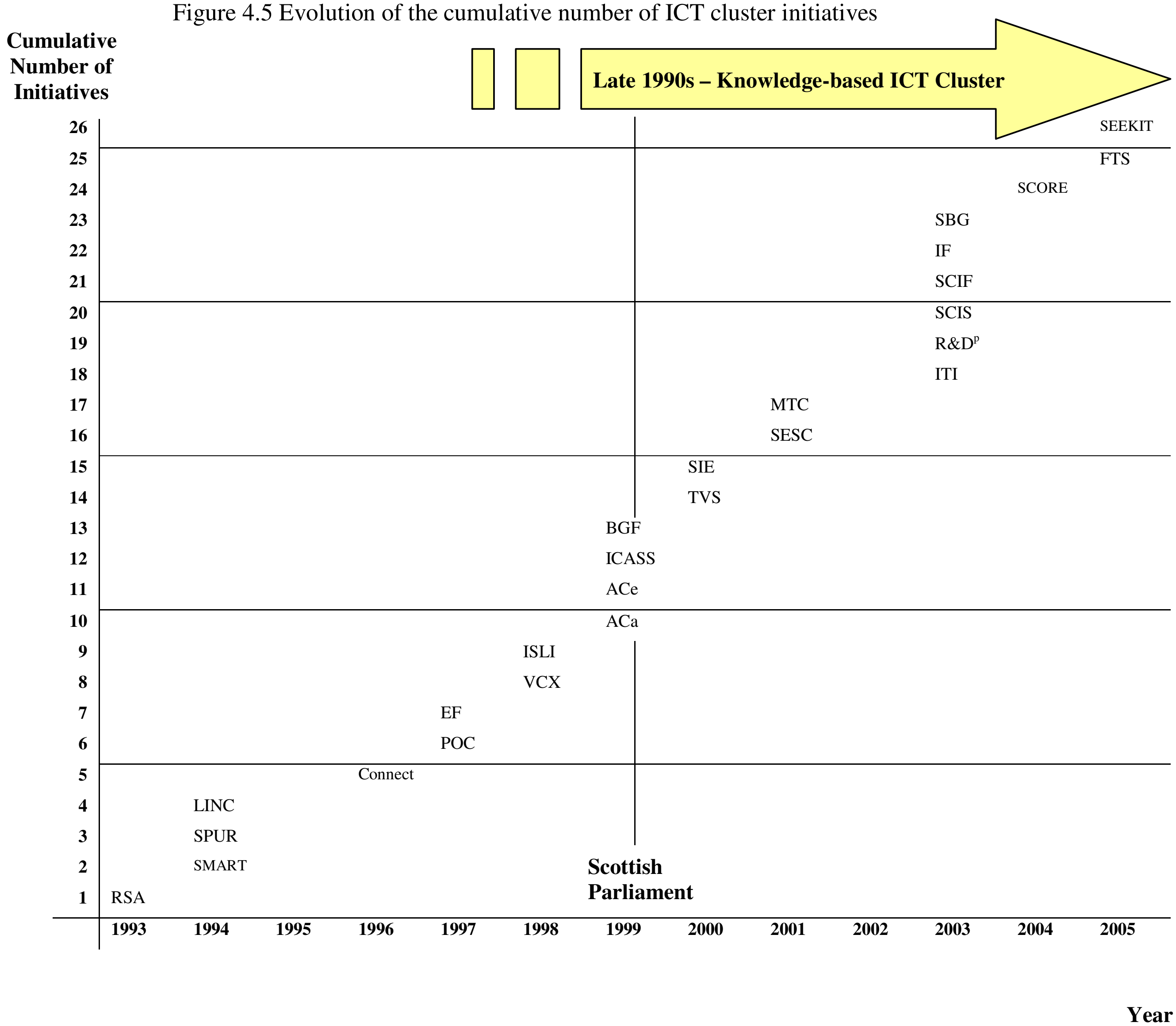
- Due to the nature of the ICT industry and the limited scope for developing local user-producer linkages, the government may support companies to seek linkages with suppliers and customers in the UK and overseas. This means the target constituents may include companies and organisations outside Scotland.
- To build a successful cluster, stakeholders have to modify their strategies and practices to align with the cluster strategy. However, stakeholders are mainly motivated by the benefits they perceive they can gain from the cluster. At this phase, the cluster stakeholders still cannot get much tangible benefits, it is questionable whether their motivation for supporting the cluster will be sustained in the long term.
- The public do not entirely understand the Smart Successful Scotland strategy and its complementarities with the cluster strategy. The Government needs to improve its communication with the cluster stakeholders and publicise the rationales for launching the new initiatives, otherwise the industry players may be confused by the two strategies.

**Alignment (4) Interacting Technologies/Constituencies**

- The launch of the Smart Successful Scotland strategy may divert public attention from the cluster strategy. The two strategies may compete for resources from the government, but at the same time, the two strategies often complement each other.
- The introduction of ITIs cost the Scottish government an investment of £450 million investment to be paid over a period of 10 years. It inevitably takes away funding that could have been made available to the ICT cluster, although one of the ITIs is for ICTs.
- The Scottish ICT cluster continues to compete with other clusters over the world for investment from foreign technology companies, yet the establishment of ITIs helps attract companies to set up operations in Scotland and exploit technologies developed there.

Figure 4.5 illustrates the evolution of the Scottish government's build up of institutions and mechanisms aimed at nurturing the growth of the knowledge-based ICT cluster. It shows how this build up has accelerated from its starting point in the late 1990s in the effort to cover all areas perceived as necessary to reach a critical mass and induce a 'virtuous cycle' of growth.

Figure 4.5 Evolution of the cumulative number of ICT cluster initiatives




## 4.3 Evaluation of Scotland's ICT cluster

The goal of the ICT cluster set up in 1999 was to strengthen the ICT sector as a whole and to enlarge the employment of the microelectronic industry to 14,500, with 5,000 in manufacturing, 4,500 in supporting industries and 5,000 in design and development by the year 2004. However, this goal has not been achieved. According to Scottish Enterprise's figures of 2005, the population working in semiconductor fabrication has dropped, rather than increased, to 2,300 people in semiconductor fabrication and 1,800 in the supply industry (Scottish Enterprise, 2005). The number of people working in microelectronic design was about 1,400 instead of the 5,000 projected by the cluster team in 1999 (Scottish Enterprise, 2005). The vision of *making Scotland one of the most enlightened locations for the next generation of system and silicon designers, developers and manufacturers* has not come true. Apart from failing to meet the goals set by Scottish Enterprise, what else has the cluster strategy achieved over the years? Below are the assessments of the contribution of the cluster strategy relating to five aspects. 1). increasing resources 2). increasing relationships 3). strengthening technological capabilities 4). achieving governance and 5). impact on the local economy.

### 4.3.1 What did the Scottish ICT cluster achieve?

**1). Increasing institutional channels and resources**

The largest contribution of the cluster strategy could be that it has increased the available institutionality and resources for development technology and innovation in Scotland. For example, physical infrastructures such as the Alba Campus, the Alba Centre, the Virtual Component Exchange, the Test Centre, the Embedded Software Centre and the Institute of Level System Integration were set up. These physical infrastructures were put in place so that ICT companies in Scotland could share them and benefit through saving costs by investing in these infrastructures themselves. As one Technical Director of an overseas ICT company said:

> *'We expect to be able to get access to resources locally faster. The MIAC make quite a lot of use of that for our contrast, EB analysis things like that, while an optical packaging centre has been set up recently, and there's a test centre. So basically, we expect to gain access to expensive equipment that we couldn't otherwise afford like the EB analysis and so on, and the cost is essentially shared between the cluster.'*

Apart from the physical resources, the cluster strategy also brought essential human resources and financial resources. Regarding the former, the cluster strategy offered incentives and persuaded ICT companies, including the inward investors, to co-locate in Scotland. This helped to attract a pool of highly skilled talent to come to Scotland because of the availability of employment opportunities. The manager of a large foreign ICT company explained:

> *'One thing that I think a cluster does is potentially attract quality people and management into an area. If they come to any part of the country where there is a cluster, and they go to company A, there is always an opportunity that when things don't work out in company A, there's company B,C,D,E down the road. I think if you get one company on its own, attracting staff to that one company it can be quite difficult because typically*

> *you're asking people to relocate, move house, relocate their family. If things don't work out, people have gone through this, and move to that point, then they have nowhere to go.'*

The funding programmes launched in association with the cluster strategy also provided crucial financial resources to a number of ICT companies. For instance, from 1997, the Proof of Concept programme awarded £5.2 million for 38 projects in ICT. The SE/RSE Enterprise fellowship also supported the formation of 10 start-up companies in the ICT sector (Scottish Enterprise, 2004). Research done by Graham (2002) confirmed that several of these would not even have been formed without the financial assistance of the Enterprise Fellowships. As the management of two indigenous ICT start up companies emphasised:

> *'Yes, extremely helpful. If we hadn't got help with SMART and SCIS at that time, that would affect our investment or money made available to the company. We got a matching sort of investment from the angel community once we received those two grants.'*

> *'We had a huge amount of support from Scottish Enterprise. We got Regional Selective Assistance, RSA, which is a sort of job bonus that, for each job that you create, you get something like £13,000 for the first year, and that was a serious consideration, because at one point the company had 36 employees and that made a huge difference, that extra money.'*

The cluster strategy also benefited the technology companies in terms of access to knowledge resources. For instance, in addition to the cluster community set up by Scottish Enterprise, the technology seminars, conferences, breakfast and dinner meetings organised by the Scottish Enterprise cluster team not only brought together a group of players with diverse backgrounds, but also facilitated the information exchange among them. Such information increased their awareness of each other and brought an understanding of how other companies related to or complemented their companies. This is exemplified by the words of the Technical Director of an ICT inward investor:

> *'It's very useful for us to get information from other cluster members about technology advance in their areas because knowing what's happening in images, knowing what's happening in display, in two years time, there will be a convergence when this product which is now impossible becomes possible and viable economically, both from a practical and economical stand point. So that's a very useful thing in the cluster.'*

**2). Increasing relationships**

In terms of encouraging alliance building among different companies and institutions in Scotland, the ICT cluster strategy only achieved limited success. In particular, the cluster strategy has not helped much to improve the situation of Scottish ICT companies having very little backward and forward linkages with local suppliers and customers. As stated in Appendix 4, the supplier linkages among ICT companies in Scotland were very weak before the launch of the cluster strategy—Scottish semiconductor fabrication plants only made very limited use of the local suppliers. The electronic companies in Scotland did not procure their semiconductors locally, while 95% the semiconductor chips manufactured in Scotland were exported. Apart from supplier linkages, the lack of sophisticated local customers, especially in system level companies, also became an impediment to relationship-building in Scotland. The lack of commercial activities among ICT companies in Scotland impaired their motivation to develop relationships with each other. After the launch of the cluster strategy, the linkages among ICT companies remained weak. The essence of clusters is networking, but as the case of Scotland showed, having a cluster strategy does not necessarily make companies in the same geographical area start relationships with each other. The following remark from the management of a small local ICT company explained this:

> *'We don't want any relationship with companies in Scotland. We don't need it, we don't seek it, there's no incentive for us to talk to other companies in Scotland because the only companies we want to talk to is our customers and there's no customer in Scotland…'*

In addition, it seemed that the cluster strategy contributed little to expand knowledge relationships in Scotland. ICT companies rarely have technology partnerships or joint R&D alliances with other ICT companies locally (technology alliances mainly took place with companies outwith Scotland.) This was due to the fact that knowledge relationships among companies are usually embedded within commercial relationships. For instance, users and producers, or partners collaborate technologically to reduce the risk and cost of tackling a specific market. In other words, commercial relationships are the prerequisite of knowledge relationships. However, as already stated, the commercial relationships among ICT companies were weak in Scotland, let alone knowledge ones. As one CEO of a local technology company explained:

> *'If there is no economic and commercial opportunity that demands this [knowledge] relationship then the government trying to encourage that relationship, it's very artificial.*

*Businesses grow and fly on the back of commercial selling…Those are the things that make companies successful ultimately. It's not just because you know everybody can find things in our places… we need more commercial activities, rather than technology activities.'*

The other explanation for the limited knowledge relationships among the ICT companies is their lack of complementarity. The interviews revealed that each ICT company in Scotland specialised in a very niche technological field, and that the companies could only find one or two companies in the region working on similar technology as themselves. Since the technology focus of each ICT company is very different, it is hard for them to develop collaborative technology networks. As the above interviewee continued:

*'Why should we want to have a relationship with an industry that are doing completely different things from what we do? There's no advantage, there's no benefit for us knowing the other high tech companies in Scotland'.*

Another type of knowledge relationship highlighted in cluster theory is the relationship between industry and university. In recent years, there is no doubt that the interaction between industry and university has intensified, but it is hard to say whether this can be attributed to the launch of the cluster strategy or to the general trend of universities worldwide. As mentioned in Appendix 4, Scottish universities were more active than before in engaging in knowledge relationships with industry, despite the fact that their level of engagement was still considered to be low in terms of intensity and in the depth of knowledge exchange. The industry-university relationship is constrained by a number of barriers such as the dominance of SMEs, the gap between exploratory and applied research taking place at universities and in industry, respectively, and because of general cultural factors and more practical issues such as the ownership of IP. A Director of a large overseas ICT company complained:

*'It's very difficult to work with them because they want to own all the IPR of any work they do. I've spoken a number of times with the electronic department at [University S] who do some opto research and [University E] also, but we never really found any way of working appropriately with them.'*

Despite the limited contribution to the development of knowledge relationships, the cluster strategy helped foster closer social relationships among different organisations in Scotland. In particular, the conferences and meetings called by Scottish Enterprise provided opportunities for the ICT community to 'to get to know people'. As the Senior Manager of an overseas ICT company talked about the benefit of participating in these meetings:

*'I think there's a lot of intangible benefit, just in terms of the informal networking opportunities that the cluster meetings will bring. I think it makes it easy for us to engage with some of the personalities and some of the other companies who are part of the cluster.'*

**3). strengthening technological capabilities**

The ultimate goal of the cluster strategy was to enhance the overall technological capabilities of the ICT cluster in Scotland. In this respect, the cluster did achieve some success, though the impact is not easily recognisable. Before the cluster strategy was launched, ICT companies mainly engaged in low level development activities with not much R&D taking place, even in the large ICT companies. The cluster strategy did rectify this situation by bringing a number of design and R&D research companies from abroad and encouraging successful university spin-out companies to develop. As stated in Appendix 4, these university spin-outs were R&D intensive, employed highly-skilled labour and had leading edge technology. They undoubtedly had very high technical capabilities. In addition, the setting up of the Institute of System Level Integration in accordance with the Alba Project also helped to improve the skill base of the Scottish workforce on R&D through its specialised education and training programmes. In this sense, the cluster strategy did contribute to enhance the overall technological capabilities of Scotland, regardless of how large the improvement was.

However, there are still obstacles ahead for the continuous improvement of the technological capabilities of Scotland. For instance, the approach of importing design and R&D jobs through inward investors was not as successful as people expected. Many of these design centres remained small and the industrial setback obstructed their growth, causing some of them to lay off part of their staff. Regarding the home-grown technology sector, the process of commercialisation from the universities was still slow, probably due to the lack of encouragement from the university side. Most of the universities in Scotland were very traditional ones and did not regard commercialisation as being their main priority—instead, their mission was in teaching and researching.

**4). strengthening of clusters**

Shortly after the launch of the cluster strategy, Scottish Enterprise did not pay much attention to the need to strengthen the clusters in order to maximise the benefits that could accrue from them. One factor that inhibited the continuous growth of the cluster strategy was the reduction in human and financial resources, of the ICT cluster. As said, in the period 2002-2003, Scottish Enterprise made a number of experts in their cluster team redundant and the budget for the ICT cluster was reduced. This made it more difficult for the ICT cluster team to carry out its action plan. Many stakeholders of the cluster saw the ease off in cluster activities, and interpreted it as a sign of cluster decline or death.

The weakening of the cluster strategy may also be due to the problems related to its formal and informal governance. First, the departure of cluster champions such as Bob Downes and Crawford Beveridge left the cluster strategy without top level leadership and direction in the government. The allegations about the mis-management cases of Scottish Enterprise also hurt the credibility of the organisation. Besides, the informal networking organisation, Scottish Electronic Forum set up by the Scottish Enterprise failed to create a consensus among the large and small ICT companies. Many ICT companies did not think they could get much benefit from the organisation, rather, they saw it as 'talking shop' and a 'social club'. The conflict of interests among large and small companies finally led to the dissolution of the organisation.

Fortunately, at the end of the study period, Scottish Enterprise could profit from the support of the new Scottish Government that formed in 1999. The new government, with greater autonomy and resources, declared its support to the cluster strategy. This empowered Scottish Enterprise to improve the formal and informal governance of the ICT cluster. With a reformed governance mechanism put in place, including a regular feedback and evaluation system, and the formation of new networking organisations with more motivated ICT communities, these helped to re-gain both the formal and informal governance of the ICT cluster.

**5). Impact on the local economy**

The ultimate aim of the cluster strategy was to enhance the economic performance of Scotland by developing an innovative, competitive and sustainable ICT sector. However, when evaluating the ICT cluster's impact on the local industry, the result was quite disappointing. Most interviewees thought that the economic impact that the cluster strategy brought to Scotland was 'little' and 'minimal'. When compared to the 'inward investment approach' of thirty years ago, which had generated a much larger economic impact in terms of employment creation, the initiatives for today's cluster strategy was much smaller in scale and tended to bring benefit to a very small niche group of actors rather than to the wider economy.

The cluster strategy has indirectly stimulated commercialisation activities at universities in that the number of university spin-out indigenous companies has more than doubled since the inception of the cluster strategy (Scottish Enterprise, 2004). However, their contribution to the local economy has been small in the short term. First, the number and size of these ICT companies is still relatively small and they do not contribute much to job creation; and second, the majority of these companies are very young (under five years) and do not generate significant revenues. Many of them need further financial support before they can bring economic benefit to the local economy.

Despite the above, one might argue that cluster initiatives like the Alba Project have brought high value design companies to Scotland. Even though the number of jobs created has been small, the salary for each highly-skilled job is equivalent to four or five jobs in manufacturing in terms of their input to the economy. Also, if these companies are successful and continue to grow or to spin out more companies, the beneficial effect on the local economy will multiply. Also, these highly skilled design companies can bring important intangible long term benefits to the economy which are hard to measure simply on economic terms. As one manager of a large overseas ICT company explained:

> *'The positive side to that is the focus of the company would be on intellectual knowledge and the sort of tacit knowledge of the individual within that small entity, which in the long term would be likely to be more stable, assuming they continue to be innovative and successful. So it's based on a small number of individuals rather than on the economic performance of a factory.'*

Unfortunately, the limited impact of the ICT cluster strategy on the local economy was curtailed by the impact of the industrial setback. Instead of seeing the positive contribution of the cluster strategy, people only saw the decrease in output and profit in the ICT sectors, the closure of ICT companies, the retreat of ICT inward investors, the huge lay-off in programmes and the dramatic rise of unemployment. The economic disaster caused by the industrial setback virtually obliterated the impact of the cluster strategy.

#### 4.3.2 Problems with the Scottish ICT cluster

From the above evaluation, it seemed that cluster strategy was not very successful. However, it is more important to investigate why the Scottish ICT cluster strategy failed to attain its goals as projected. To answer this question, it is necessary to consider the following three aspects: 1) the problem with the Scotland's overall structure 2) the problem with the execution of the cluster strategy and 3) the problem with the participation of the cluster.

**1. Problem with Scotland's overall structure and technology nature**

**a. Misalignment with the industrial structure**

One factor that inhibited the success of the ICT cluster in Scotland was caused by the historical and structural factors highlighted in section 4.1.2. To sum up, Scotland does not yet have a technology base strong enough for an ICT cluster to develop in. The number of ICT companies was small (about 400 prior to the launch of the ICT cluster strategy) and the majority of them were inward investors who did not have significant design and R&D capabilities. The indigenous ICT sector was mainly constituted by SMEs which were constrained by human and financial resources. In short, the weak 'ingredients' or 'constituents' conditioned the initial state and limited the growth potential of the Scottish ICT cluster. In addition, the small technology base also made company-company linkages hard to develop because of the lack of commercial opportunities and complementarity they offered each other. ICT companies generally found that they had nothing to contribute, nor were they useful to other companies and vice versa, and this inhibited the generation of synergies in the cluster. A few interviewees had this to say of the problem:

> *'There is no critical mass in Scotland, Scotland is very small, in terms of number of companies, the number of people, the amount of investment, I mean Scotland is a population of 5 and half million people…' (Director of a large overseas ICT company)*
> *'I think that why we fall down, apart from intellectual capitals, I don't think we have a huge demand on other companies …'(Senior Manager of an overseas ICT company)*

> *'I would say our contribution to technology so far has been limited. I think as a company we do a lot of smart things…but I think the benefit to other companies in Scotland is limited.' (Chief Executive of a local ICT company)*

Local universities were good at basic research but contributed very little to the local ICT industry. The company-university linkages also suffered from the problem of the lack of demand of technologies from universities. As mentioned in Appendix 4, the dominant majority of the SMEs (excepting the recent university-spinouts) in the ICT sector seldom attempted to carry out R&D, apart from some product development or customisation works. The lack of R&D activities led to their low absorptive capacities, and created difficulties for them in having technological collaboration with universities. As one interview who is the CEO of a financial networking organisation said:

> *'I think the universities have focused significant resources to actually try to develop better collaborations locally, but the problem is we haven't got the population of companies which are sophisticated enough to work in these collaborations'*

**b. Misalignment with the nature of technology**

The goal of the Scottish ICT cluster strategy was set to '*develop innovation as the core by exploiting research from industry, university and research institutes*'. However, the level of success in meeting this goal was hampered by misalignment between the cluster strategy and the nature of the ICT technology. ICT technologies, including electronics, microelectronics, optoelectronics and communication technologies are driven mainly by user-centred innovation processes, rather than producer-centred innovation processes. Due to the growing importance of 'configurational' character and 'interoperability standards' of ICT (Williams and Edge, 1996), many design and R&D works for ICT are focussing on the processes of customisation, specification and configuration of the technology for specific customer needs. In other words, to be successful, an innovation in the ICT should be developed to meet customers' needs. As a consequence, linkages among ICT companies are mainly oriented towards customers or users as the main sources of innovation and technology input for their innovation, not universities.

However, the cluster strategy adopted by Scottish Enterprise tended to encourage industry-university collaboration from the 'technology push' approach. That is, they hoped that the technologies developed at Scottish universities would be of use to local ICT companies. Unfortunately, they missed the fact that there was a serious mismatch between the university research and industry needs, as stated in section Appendix 4. Scottish universities were traditional and their strengths were in exploratory, basic research and their technologies were not necessarily what the industry wanted.  Therefore, the 'technology push' approach seemed to achieve very little in Scotland. As one interviewee who was from a local university said:

*'What I think too much focus has been on in the past is too much of the technology push…we all have this research going on at universities. Surely something should happen to that out there in the Scottish industry base. I think that's the wrong way round. I think you need actually technology pull not technology push…'*

## 2. Problem with the government

### a. Top-down approach with no demand from the bottom

One of the problems concerning the governance of the Scottish ICT cluster strategy was its top-down approach. To be effective a cluster strategy requires cooperation and participation of all the stakeholders and so should employ a bottom-up approach rather than a top-down one. In many case studies of clusters in other countries, the implementation of the cluster strategy was through a bottom-up approach. The industry reflected their demands to the government and the government made efforts to meet their needs. For example, as described by Botham (1999) regarding Austin's IT cluster building story, the region attracted a large ICT corporation, Microelectronics and Computer Technology Corporation (MCC), to be their anchor cluster company due to the efforts of the Chamber of Commerce in raising money through a public campaign for their location package. This showed that the industry members in Austin not only fully supported the cluster strategy, but that they were also highly motivated to take part in it. However, in the case of Scotland, most industry members felt uncomfortable with the top-down approach. As mentioned before, they were particularly disdainful of the government's 'picking winner' approach as they did not think the government had the credibility and capability to do so—in many cases, the government took the wrong option. The top-down approach seriously affected the willingness of the cluster players (including companies and universities) to participate in the cluster strategy. An interviewee who is the Director of a university's technology transfer office had the following comment:

*'I think by and large it was, it [cluster strategy] was that people have worked together for their own collective motives, it's been a bottom-up approach which tends to make things work, rather than a top down approach, which I think is one of the systems here.'*

### b. Lack of focus

Lack of focus perhaps constituted the second major problem of the Scottish ICT cluster strategy. Scottish Enterprise was too ambitious in its cluster strategy. Apart from the first four clusters (semiconductors, food and drink, oil and gas and biotechnology), they were attempting to build another four, or even more. Being a small economy, Scotland could probably support three or four clusters by building on its truly competitive industries. However, Scottish Enterprise's broad brush approach has inevitably led to a thin spread of resources across all the clusters and, as a result, reduced their impact on the economy. Below are the comments made by different interviewees:

> *'I do think in the past Scottish Enterprise has probably invested or spread its money too thinly, and has tried to support different initiatives and different companies in different sectors and all the rest of it. And I think the one thing that is probably better is to use your capital and to pick what we are competitive at in a global sense here in Scotland.' (Director of a venture capital firm)*

> *'I think the main problem of the cluster is' too many'. I think a country of a size like Scotland is only justified in having three - five clusters, not seven clusters and four additional sectoral groups that we currently have. Consequently, I think many of our resources are spread too thinly, and that we therefore find it difficult to fulfil all our missions; we're going to see it as times get tougher in terms of the availability of resources.' (Director of the cluster team)*

> *'I think given Scotland's size, I think having multiple clusters is probably a bad idea. I appreciate that there is a need to wait and to look at all growing opportunities, but in fact, maybe a better chance is to pick one and put everything behind it.' (CEO of a local ICT company)*

In addition, the Scottish government tried to develop too many small initiatives to support innovation. Their intention was to have each initiative address a specific gap in the various aspects of technology development. Since these initiatives were large in number, they confused the industry members about their value and functions.The cluster players were unable to perceive how these small initiatives fitted together with the larger cluster strategy. After all, a more 'focused' approach—to identify the core strengths of Scotland and to build the cluster around—was highly recommended by the interviewees. Here are some of the interviewees' statements:

> *'There's endless people and it seems to be endless organisations and I think you would lose your life tracking and understanding them and what they actually do…their attention is so diluted that I feel it might be better directed to a very specific target, give the responsibility to improving that, rather than a broad brush approach.'(Managing Director of a local ICT company)*

> *'There seems a lot of little initiatives. I don't really know what the value is that some of them bring, because they are quite small, quite specialised and not a reason to exist in our field.'(CEO of a small local ICT company)*

*'That are many such organisations active in Scotland, too many. One of the most difficult thing is communication between the many, well intended activities and to foster all to grow. A smaller number of better staffed activities would be probably significantly more efficient in my view.' (Technical Director of a large ICT company)*

**c. Lack of leadership**

The cluster strategy of the Scottish ICT cluster also faced problems of a lack of leadership. Although cluster strategy was initiated by Scottish Enterprise, the leading role of Scottish Enterprise was hampered by a number of factors. The cluster stakeholders thought that Scottish Enterprise was lacking in an understanding of the industry as a whole. They did not have a clear idea about the composition, nature and characteristics of the ICT sector. Without an in-depth and thorough understanding of the industry, it is almost impossible to design a cluster plan which can fit Scotland's situation and meet the needs of the cluster stakeholders. One interviewee who is the CEO of a financial networking organisation had this to say of Scottish Enterprise:

*'In the cluster team of Scottish Enterprise, nobody really defined the cluster, nobody really tracked who these companies are. There is no real definition, there is no real break down which categorises this, like we have a thousand companies, a hundred start ups up to early stage, three hundred at the development stage, none of these data existed. So how can you support a cluster if you don't understand the dimension of the cluster? Scottish Enterprise throughout all these initiatives which is supposed to help companies, raise money, develop R&D, become more innovative but there is a huge disconnection between Scottish Enterprise's cluster teams and the private sector.'*

In addition, the cluster players were concerned about the lack of commitment from the Scottish government. They perceived that the government was prone to 'short-termism'—most government plans only lasted for two or three years, perhaps for the sake of winning an election, and then would be changed when other people were appointed. Moreover, they attempted to create initiatives or programmes in order to catch the eye of the media but then would change their minds due to their 'political agendas'. An interviewee who is the Director of an ICT research institute said of this problem:

*'Scottish Enterprise have a tendency to set up things and to get headlines of setting up initiatives, but then they don't give enough sustaining funding and they also have the tendency to set up competitive and similar initiatives, which is very confusing to the industry players, and defeats their roles which are meant to be developing enterprises… because all they are doing is becoming a self-perpetuating organisation in their own right rather than a tool in the industry.'*

Apart from the problem of the lack of leadership from the government side, there was also a lack of leadership on the industry side. As many successful clusters demonstrate (such as Japan and Finland's models), a leading ICT company with substantial economic and technological capabilities becomes the nucleus of the cluster and draws many small companies to cluster around it. However, there is no such large leading ICT company in Scotland that seeks either commercial or technological relations with other ICT companies. In the words of an interviewee who is the CEO of a local ICT start ups:

> *'A cluster will work if there is a company in my sector who is at the forefront of the technology, in the forefront commercially and who is looking to the local market to encourage them to come in and provide social status. I think without that, one or two companies who are big enough, have enough momentum, enough commercial progress, it doesn't work'.*

Although there were a number of large ICT companies engaged in the ICT cluster, the government failed to persuade them to take on a leading role in the ICT cluster. One interviewee who is the Managing Director of a technology management company explained this:

> '*The big industry players were quite happy to perform as advisors, but they were unhappy about getting engaged in making strategic decisions, partly because a lot of these companies were subsidiaries of American corporates and had difficulties in engaging in that level of decision making at the local level. And also they were often significant beneficiaries of grant aid and stuff like that, so they may have been restricted by their ability to negotiate.'*

As a result, there was no powerful leadership from either the government side or the industry side to provide strategic direction to the constituency building process of the ICT cluster.

**3. Problems with the participants**

Cluster building is an activity where collective action is required from all the stakeholders of the cluster. However, as the case of the Scottish ICT cluster showed, major cluster actors were not motivated to take part in the constituency building process. The interviews with the key players revealed that the constituency building process was troubled by a number of communication and implementation issues.

**a. Aims & objectives were unknown to players**

First of all, key stakeholders of the cluster did not know about the aims and objectives of the cluster strategy. Although the aims and objectives of the ICT clusters were jointly designed by the members of the cluster community, such communities only involved a small number of key individuals and it was obvious that the aims and objectives of the cluster strategy did not disseminate over to the wider community. To quote a few of the interviewees' words:

> *'I don't know what they are, so it's been a long time since anyone spelled it to me this is cluster strategy. The last time is probably about three or four years ago.' (Chairman of an ICT networking organisation)*
>
> *'I have to confess ignorance because I know very little about the aim and objective of the cluster.'(Managing Director of a local ICT company)*
>
> *'I cannot comment on the cluster strategy adopted by the Scottish Enterprise, because I don't know, I'm ignorant of them. I don't know enough to make a comment.' (Technical Director of a large ICT company)*

**b. Lack of perception about their involvement**

In addition, it seemed that the major players were lacking a clear perception about their involvement in the cluster. Many interviewees did not see themselves as participants in the Scottish ICT cluster. Below are their words:

> *'I don't think we participate in what I would say is a recognised cluster activity...'(Technical Director of a large ICT company)*
>
> *'The definition of cluster would be an entity with multiple connections with other entities, so I would see a network between companies. I don't think our company does that...'(Managing Director of a local ICT design company)*
>
> *'We haven't actively positioned ourselves as part of the cluster…'(CEO of a local ICT start-up)*

According to the interviewees, Scottish Enterprise never formally invited or persuaded them to take part in the cluster. An interviewee who is a Director of a large ICT MNC said of this:

> *'Stay in the cluster, or not in the cluster, there is no difference, there is no formal invitation to the cluster I'm aware of. Basically, someone in Scottish Enterprise wrote a cluster map, and if they know you have the skill, you will be located in that cluster map, there is no payment or financial advantage for being in the cluster.'*

Without a clear definition of their participation in the ICT clusters, major players did not know their roles and how were they supposed to behave in a cluster. They did not realise that by being a part of the cluster, they had to align their company strategy with the cluster strategy—to network with other cluster players. As many interviewees admitted, they were merely pursuing their own strategies without paying attention to their 'fitness' within the cluster strategy. In their words:

> *'We don't have many relationships with other Scottish companies, and we have almost no relationship with the university and other academic bodies, so we exist as a stand alone business entity with certain objectives which are very much our own, driven by our agenda.' (CEO of a local ICT start up)*
>
> *'It's difficult for me to know because I'm separated from it. We pursue our own business policy…'(Managing Director of a local ICT company)*
>
> *'I tend to think about the position within Scotland in the business sense, rather than do I belong to cluster or anything like that.' (Director of a VC company)*

**c. Unmotivated to take part because no benefit gained**

Moreover, the major players of the cluster were unmotivated to take part in the cluster because they did not perceive any benefit to be gained from their participation. They did not think the cluster strategy could bring any tangible or vital advantages to their companies or to the regional economy. The following quotations reflected this:

> *'I don't really see it as an opportunity to put together companies with similar backgrounds and hope that they will have business trading relationships.' (Investment Director of a VC company)*
>
> *'I would struggle to think of any single benefit of clustering companies together geographically, unless these companies are trading with one another' (Chief Technology Officer of a local ICT company)*
>
> *'I do not perceive us as gaining a great deal of benefit from the cluster.'(CEO of a local ICT start-up)*
>
> *'I've seen nothing come out of it at all. Nothing benefits my organisation and my position in the organisation.'(Director of a large ICT MNC)*

As a consequence, it became very difficult for Scottish Enterprise to mobilise the major players to collaborate with each other and to take collective action. One interviewee who is a Director of a university technology transfer office gave his reason for this:

*'I think what you have to do is to develop a system which the people are willing to cooperate with and people usually willingly cooperate because they see some benefit to them.'*

As the major players did not realise the aims and objectives, did not recognise the roles they had to play and did not perceive any benefits to be gained from the cluster, they failed to develop the shared motivation and willingness required to take part successfully in the Scottish ICT cluster strategy.

### 4.3.3 Lessons learnt from the experiences

Although the cluster strategy did not achieve the targets as planned in 1999, the experience of building an ICT cluster provided a number of valuable insights for cluster builders in other part of the world. Those insights are summarised as follows:

**1. Set up of physical infrastructure or 'institutional thickness' alone does not make a successful cluster**

Many people have the misunderstanding that building clusters mean to construct a number of physical infrastructures or create a number of institutions. Therefore, in many countries, the most common way to build clusters is to create things like science parks, technology parks, incubation centres, industrial research institutes, mid-stream research institutes and technology centre of excellence and so on. However, all these things should only be viewed as a part, but NOT as all the parts of a cluster. The presence of these institutions or infrastructures may help the cluster to be more effective, but they do not guarantee the success of the cluster.

In fact, the essence of the cluster theory is about bringing together companies and organisations who are complementary in terms of resources or knowledge and to encourage them to collaborate with each other. By doing so, a bigger whole is created by drawing on the strengths of different parts in that each part can gain some benefits from the presence of the other. For instance, there are a group of organisations, large and small, that specialise in different parts of the value chain/production chain. They collaborate with each other to form a bigger system and address a specific market together, as if they were the equivalent of a single company. In other words, the two most important factors in a cluster are those organisations with complementary resources or skills and the depth of their networking activities with each other. Yet, the case of Scotland also showed that in some cases, complementarities of benefits may not be found in the cluster. In this happens, the government may need to develop a more 'focused' approach (e.g. Scottish Enterprise's approach to focus on a single laser product) and to assist the cluster actors to identify their potential complementarities.

**2. Setting the goals in realistic terms**

The targets of the ICT cluster were set in the mid-1990s when the Scottish ICT industry was still booming. Therefore, their targets were very ambitious. As Scottish Enterprise's data shows, by the time the ICT cluster strategy was launched, there were only 500 microelectronic designers in Scotland (Scottish Enterprise, 2000a). It was very difficult to increase that number of designer engineers by 10 ten times (to 5,000) in a few years, regardless of the efforts made to set up the Institute of Level of Integration to train local talent or to recruit from overseas. Other goals of the ICT cluster were to develop design and R&D as the core of the ICT industry and to employ half of the total workforce in the sector. However, these goals were unrealistic in view of the low technological capabilities of the ICT sector. Developing technological capability is a very slow process. One cannot expect the capabilities of the region to leapfrog from a very low level to a very high level without allowing sufficient time for the learning process to take place. Indeed, the vision of becoming a '*world center of microelectronic design*' is still light years away! In short, it requires more time and effort, more specifically, the quality and correctness of the effort to bridge the large skill gap between the cluster's vision and the reality of the situation, there being no short cut or quick fix to capability building.

**3. Develop a critical mass when proceeding to the next phase**

One of the biggest problems in Scotland, as identified in the previous section, was the lack of a critical mass. Having a critical mass of companies who can possibly gain benefits from cooperating with each other is the prerequisite for building a cluster. When the critical mass is present, the ICT companies will network with each other naturally. When opportunities are present for companies to share common interests, they are willing and motivated to collaborate in common projects so as to capitalise on the opportunities. Similarly, when a critical mass of technology companies has been developed, the attention of the venture capitalists will be drawn to the region. Therefore, Scottish Enterprise need to maintain the effort to develop a critical mass of ICT companies in Scotland by giving more incentive and support for new company development while proceeding to the next phase of their cluster strategy.

**4. Support indigenous companies v/s attract inward investments**

Scottish Enterprise tried to create a large number of intellectual jobs for the ICT sector by attracting inward investors. However, their plan did not work out accordingly. For instance, Cadence Design, the anchor tenant of Alba Campus did not in fact employ 1,900 engineers as it had originally announced in 1997 (details discussed in Appendix 5), while many other foreign design companies remained at zero growth in headcount during the industrial setback, although they may not have decreased in number. In view of the limited success in the attempt to import high value companies and jobs to the region, it leaves Scotland little choice but to grow its own indigenous ICT sector. The government also hopes that with the successful leading technologies being developed at local companies, this may attract large international corporations to come and invest in these ICT companies.

**5. Market demand vs technology push approach**

Another revelation from the early phase of cluster development was the ineffectiveness of the technology push approach used in the university commercialisation process. The process of technology diffusion from the high education sector to industry was very slow, as universities had no real knowledge of what the companies wanted. At the later phase, Scottish Enterprise tried to rectify this problem by deciding on a mechanism that worked the other way round – namely, to understand the industry's needs first and let the universities conduct research for them. The demand pull approach adopted by the ITIs may help align university research with industry's aims and bridge the gap between the two.

**6. Discriminative approach vs inclusive development**

To be successful, a cluster must be based on the real (not aspired) strength of the region i.e. it has to be part of a global competitive technology and then a supporting infrastructure can be built around it. This cannot be done as an inclusive approach (i.e. to achieve equal development in everything) as this will dilute the resources and efforts needed for cluster building. Therefore, when developing a cluster, a discriminative approach, especially in the early stage, is necessary. Scottish Enterprise has to identify the world class technologies and proactively provide resources to help that process develop. Adopting an inclusive approach through not wishing to destroy the breadth of knowledge or through being afraid of upsetting other industrial groups is a strategy that is doomed to failure in the face of limited resources. After all, big corporations will only come to Scotland if they perceive opportunities for investing in world leading technologies.

**7. Necessity of helping the public to understand cluster strategy**

Another problem regarding the implementation of the cluster strategy was caused by the concept of ‘clusters’ itself. Originated from an academic theory, the concept was not an easy one for industry players to understand. Cluster strategy is merely a channel, a means to achieve certain objectives; that is, to generate economic benefits through developing globally competitive technology industries. Cluster strategy is one of the means of achieving that by leveraging the strengths of different players in the science base. However, it is obvious that cluster players were unclear about the objectives of the strategy, for they did not know what ‘cluster strategy’ was and how they should take part to help achieve the overall objectives. This demonstrated that Scottish Enterprise did not communicate the cluster strategy very well to the major players and such lack of clarity in the strategy per se caused confusion to the cluster stakeholders, and thus hindered the effectiveness of its implementation.

### 4.3.4 Challenges for the Scottish ICT cluster ahead

Although Scottish Enterprise has made serious efforts to re-align the constituency building of the Scottish ICT cluster, a number of challenges lie ahead and may cause a negative impact on the continuous and sustainable development of the Scottish ICT cluster.

**1. Structural problems are hard to solve**

The largest impediment to cluster building in the ICT sector in Scotland is its inherited structural problems. The ICT cluster building efforts over the last five years have only brought limited changes to the industrial structure. The number of ICT companies in Scotland is still very small. Statistics from Scottish Enterprise show that there are only 360 companies in the microelectronics and optoelectronics cluster. Although the number of indigenous design companies doubled and the number of designers engaged in research and development rose by almost two thirds to nearly 2,000 over the last five years (Scottish Enterprise 2004), this number is not yet enough for constituting a critical mass for the ICT cluster to generate significant technological and economical impacts to the region.

In addition, although Scottish Enterprise has tried to encourage the development of local user-producer relationships, this task will continue to be extremely difficult to achieve. Due to the high cost structure in Scotland (increased National Insurance contributions and corporate tax, strong currency), it seems that Scotland is in no way ready to compete with other emerging economies, such as India and China, for large volume manufacturing jobs. It is encouraging to see that BAE Systems has created a local supply chain for the production of its laser products in Scotland. However, it is the author of this thesis's guess that as BAE Systems is a defence company, the motive for putting a Scottish supply chain in place may be a strategic or security measure, rather than one driven by purely commercial motives.

Regarding other ICT products for the commercial market, outsourcing volume manufacturing to low cost economies is almost a universal trend and Scotland has very little power to reverse it. In the long run, only high value and small volume manufacturing jobs may be retained in Scotland, such as those necessary for the manufacture of high value compound semiconductors for optoelectronic products. Asking companies to use local suppliers and manufacturing in a high cost base only makes them uncompetitive to the other global competitors. ICT companies are commercial entities operating under their own economic motives, hence, the more reasonable way out is to encourage ICT companies to develop networks with companies in other clusters outwith Scotland. For example, Polaroid developed technology partnerships with optoelectronic companies in Taiwan, while BAE Systems have formed alliances with companies in Singapore. Governments in Taiwan and Singapore are renowned for their enormous efforts in supporting high technology cluster building in their respective countries. Perhaps Scotland can finds ways of leveraging on the investments of other governments in their high technology clusters by developing cooperative agreement with them (such as to cooperate with countries within the European Union) and gain extra resources for themselves. After all, only the survival and growth of companies can bring economic and societal benefits to the region. The Government should help ICT companies in Scotland to reap the benefits from the international division of labour and leverage on the resources from other geographical areas, both inside and outside the UK.

**2. Difficulties in motivating players to start networking**

In theory, cluster players are drawn together by their commonalities, such as a common market, common challenges or common benefits. In the case of the Scottish ICT cluster, it is the common vision of '*developing Scotland into the world's ICT design centre*' that has attempted to bring the cluster players from similar sectors and markets to work together with the public sector. However, in practice, having a common broad vision is not enough. As the findings from the interviews showed, cluster players lacked the motivation to take part in the cluster and engage in networks with each other due, by and large, due to the fact that they failed to see how they could benefit from such an association. Although the motivation for companies to participate has been heightened after the industrial setback, their motivation cannot be sustained unless they perceive that tangible benefits can be acquired by participating in the cluster.

Simply persuading the stakeholders by talking to them about vision or the importance of innovation is not enough to change their mindsets or behaviours, it is equally important to convince them that they can benefit from the ICT cluster. Government should be more proactive and effective in communicating to cluster players about the benefits they can gain from the cluster, such as increased resources (physical and financial), tapping into a university's knowledge resources and the regional benefits created by job creation, and so on. In addition, taking part in the cluster community also represents a good opportunity for networking with other ICT companies. Such networking opportunities enables ICT companies to be aware of what is happening in the technological field and to get to know other ICT companies or research organisations which can offer them complementary skills or resources. This can help them gain a first mover advantage to form potential partnerships with other organisations in the cluster in order to tackle a common market together if and when such a situation arises. Having said that, without some successful examples to demonstrate that this can happen, it will be very difficult for Scottish Enterprise to convince ICT companies the benefits of networking and to motivate them to be active players in the ICT cluster.

**3. Communication problems between government and the cluster stakeholders**

The constituency building effort of the ICT cluster in the previous phase was hampered by a number of communication problems between Scottish Enterprise and the cluster stakeholders. In the present phase, Scottish Enterprise has tried to improve its communication with the cluster stakeholders. A feedback mechanism has been set up to seek constructive opinions from them, to ensure that the cluster activities are properly monitored and that the effectiveness of the programmes is appropriately evaluated. However, it seems that Scottish Enterprise is still having problems in promoting its new initiatives to the cluster stakeholders. For instance, a lot of industry players felt that they did not understand the cluster or some of the initiatives like ITI at all. If Scottish Enterprise does not find ways to improve its communicaiton with the cluster stakeholders and explain to them what the goals and mission of the cluster are, then the problems that surfaced before in the ICT cluster (i.e. lack of support and confusion from the cluster players) may continue.

**4. Sustaining long term financial commitment from the government**

In the new phase of cluster building, Scottish Enterprise added a number of new initiatives to those already operating in the region. This has raised concerns from industry members about the ability of the government to sustain a high level of support to the cluster strategy over a long period of time. In fact, a lot of cluster supporting initiatives may take a very long time to generate a visible impact on the local economy. However, the government formerly started a number of new initiatives but were too impatient to wait for their effects to emerge. The new initiatives are inevitably competing with the other older initiatives in the cluster strategy for limited resources—the yearly budget for Scottish Enterprise was fixed at £450 million. To solve the funding problem, Scottish Enterprise may actively look for other funding sources outside Scotland, such as those in the UK and EU. For example, the Proof of Concept Funds received an injection of funding from the EU in 2004.[21]

**5. Declining emphasis on the cluster strategy**

Finally, there is concern about the declining emphasis on the cluster strategy by the Scottish Government. The term ‘cluster’ is less frequently used in Scottish Enterprise’s official documents and web sites and this has led many people to think that the government has forfeited the cluster strategy, or that the cluster strategy has been replaced by the Smart Successful Scotland strategy. However, as stated in the previous section, the cluster strategy is still being used by Scottish Enterprise to support the development of ‘key industrial sectors’. The key ideas and key programmes for supporting cluster building, such as encouraging user-producer relationships, industry-university linkages, supporting the commercialisation process, and the provision of public infrastructures for the shared use of

[21] The Proof of Concept was granted a further funding of £10 million by the European Regional Development Fund in 2004 (Scottish Enterprise, 2007).

the same sectors, are still going on. They are embedded within the wider holistic economic strategy set out in Smart Successful Scotland.

In fact, many interviewees thought that the Smart, Successful Scotland programme is better than the 'cluster strategy' in terms of ease of understanding. As mentioned in the previous section, the term 'clusters' has caused much confusion to the cluster players and stakeholders because 'clusters' is an artificial term. Many players did not really understand what 'cluster' meant, what the philosophy behind it was and how they should act in the 'clusters'. It revealed that one of the problems of cluster building is the language 'cluster' itself. To a certain extent, it hampered the constituency building of the ICT cluster and the effectiveness of the implementation of the cluster strategy. Now Smart, Successful Scotland only focuses on three key themes—growing business, global connection and skills and learning. Thus it is easier for the general public to know and understand the government's overall strategic direction. In this regard, it may help the public to support the implementation of the strategy and facilitate communications between the public and private sectors.

### 4.4 Chapter summary

This chapter has illustrated the Scottish government's attempts to create an ICT cluster through its policy programmes. To help understand the cluster building process, the analysis was divided into two levels: 1) the regional level and 2) the cluster level. These two levels are deeply inter-connected and mutually influence each other.

Section 4.1 provided the context of the cluster building process. It began with a summary of the overview of economic and technology environment of Scotland and a review the relationships among different actors in the clusters, including inter-firm relations, university-industry relationships, relationship between firms and the financial sector, as well as the government's involvement in supporting technology development. The second part of this section analysed the major contextual characteristics of the ICT industry/sector with the NSI/IC framework. It showed that the ICT cluster was constrained by the industry's structural factors—domination by inward investors, a small indigenous sector, a lack of integrated linkages and low technological capabilities. The knowledge networks have not been developed among the ICT companies and the industry-university networks were weak and full of barriers to progress. While the development of new businesses was hampered by lack of venture capital in the region, the government tried to make up for the ‘market failure’ by introducing various funding schemes.

Section 4.2 talked about the actual processes involved in the constituency building of the ICT cluster at the cluster level. It mapped the development of the ICT cluster in four phases: namely birth, growth, decline and evolution. Despite a long history of attempting to build clusters without success, the approval of the cluster policy by Scottish Enterprise in 1996, after a prolonged political debate, marked the beginning of the first phase of the knowledge-based ICT cluster development. The second phase described the strategy-making process, including the design of the vision, goals and actions of the ICT cluster. The strategy was translated into different policy programmes and initiatives to develop and strengthen the ICT cluster. The third phase highlighted the difficulties met by the ICT cluster after its inception. The industrial setback defeated the efforts that the government had made to support the ICT cluster and the latter also faced a number of governance problems. During this period, the new Scottish Parliament was formed and a new Smart Successful Scotland strategy was introduced. This new strategy, supported the theme of cluster building and technology development and helped the declining cluster to get back on track. Finally, the fourth phase described how the government embarked on the re-alignment efforts to rectify the deficits in the cluster building process, such as attempting to overcome the structural problem through stimulating company creation, focussing on network-building among different cluster players and improving the overall governance of the ICT cluster.

The final section of this chapter analysed the factors leading to the less-than-expected results of the Scottish ICT cluster. They were mainly caused by mis-alignments with the industrial structure, nature and maturity of the ICT technology, management issues of the government and the problems of the participants. All these showed that building a cluster is an extremely difficult task. When implementing a cluster strategy in a real life context, it proves to be much more chaotic than when described in theory. The lessons learnt from Scotland’s cluster building experiences might be helpful for governments in other regions or countries to tackle these troublesome factors and improve their cluster-building efforts.

# Chapter 5: Data Analysis—ICT cluster of Hong Kong

**Objective: to present the research results in the STC framework and analyse them for the relevance to the research questions**



## 5. Introduction

This chapter presents the results of the study of the ICT cluster building process ('meso' level) in Hong Kong, using the STC approach and concentrating almost exclusively on the longitudinal analysis of the attempt to build up a cluster by policy design. A brief first section reviews the overall economic/industrial and technological environment of Hong Kong ('macro' level), including a Table that makes use of the NSI/IC approaches to summarise the findings. This environment represents the general existing conditions for the ICT clustering processes in Hong Kong, and can also be seen as the starting conditions for the policy-driven clustering process. The full discussion of this 'macro' regional level is found in Appendix 6, thus completing a two-level of analysis in the long version of the thesis.[22]

[22] Unlike for the Scottish case, no Appendix is provided addressing the 'micro' level of 'project' constituency-building for the case of Hong Kong. Thus, only a two-level analysis for Hong Kong is included in this thesis, although the research was done, focusing on the Hong Kong's flagship project—the Science Park.

Following the brief initial section, the bulk of the chapter concentrates on the development of the Hong Kong ICT cluster over time. A final section gives a comprehensive evaluation of the Hong Kong technology cluster, followed by a brief summary of the chapter. The monetary figures quoted in this chapter are in Hong Kong dollars (HK$). The exchange rate for British pound (£) and the Hong Kong dollar (HK$) is approximately £1 to HK$13.5.

## 5.1 Brief summary of 'macro' Level (industry/market level)

### 5.1.1 General background about Hong Kong

Hong Kong is a small economy with a population of 6,759,500 in 2001 (Information Services Department, 2002a) and a GDP of HK$1,271.1 billion in 2002 (Census and Statistics Department, 2003). Hong Kong used to be a manufacturing base for a number of light industries in the 1960-70s. The decline of the manufacturing sector over the years left Hong Kong dominated by its service sector which accounted for approximately 84% of the total employment and GDP in 2002. (Census and Statistics Department, 2003) The manufacturing and construction sector only accounted for 15.5% of the total employment and 12.3% of Hong Kong's GDP. (Census and Statistics Department, 2003)

The GERD of Hong Kong in 2002 represented 0.6% of the GDP (Innovation and Technology Commission, 2004), which was relatively low compared with Asian countries' average GERD of 1.5% of the GDP. (UNESCO, 2004) The research base of Hong Kong was largely confined to the higher education sector, accounting for 64% of the total GERD, whilst the business sector only accounted for 33% of the total GERD in Hong Kong. (Innovation and Technology Commission, 2004) A research report published by the government in 2002 further revealed that 99.7% of the overall private sector did not engage in any R&D activities. (Census and Statistics Department, 2002a)

The origin of the Hong Kong ICT industry could be traced back to the late 1950s when a number of inward investors set up their electronics manufacturing facilities in Hong Kong to tap into the low labour cost there. However, due to the gradual increase in land and labour costs, these inward investors moved away, leaving a void filled by local ICT companies which continued to act as the OEM manufactures for MNCs. ICT companies in Hong Kong nowadays are characterised by their small administrative headquarters in Hong Kong and large manufacturing facilitates in mainland China, in particular since late 1970s when China adopted an 'Opening policy' for Hong Kong's companies.

Despite the close relations between ICT companies and their local suppliers, the level of knowledge exchange among them is low, due to the fact that they mainly use them for standard materials and components. On the contrary, ICT companies tend to have closer relations with their customers who are overseas. ICT companies in Hong Kong also have weak relations with universities, largely because there is lack of demand for technology from industry, and universities are unmotivated to engage in commercialisation activities. Also, there is an absence of mid-stream research institutes to help bridge the gap between them.

Hong Kong being the financial centre of Asia and a place well known for its entrepreneurial culture, the birth rate of technology ventures is far from impressive. Venture capitalists mainly take advantage of Hong Kong's convenient geographic location and well developed banking infrastructures, but seldom invest in technology companies in Hong Kong. To them, technology ventures in Hong Kong are either not globally competitive enough, or too small in scale to offset their high administration cost in the investment process.

The Government of Hong Kong used to be a firm believer of 'laissez fair' and historically, there was no explicit policy to support any particular industry. After the Asian Financial Crisis, the government began to realise about Hong Kong's vulnerability to the external economic environment due to its overreliance on the service industry and decided to employ a more holistic approach to support the technology industry. Therefore, a cluster strategy embracing the building of physical infrastructure, supplying of funding, cultivating human capital and supporting technology ventures, etc. is being applied with the aim to build a knowledge-based ICT cluster in Hong Kong.

*The detailed analysis of Hong Kong's economic and technology background, as well as the relations among the major actors of the cluster can be found in Appendix 6.*

### 5.1.2 Hong Kong's ICT cluster in the NSI/IC framework

Table 5.1 makes use of the NSI/IC framework to summarise the major characteristics of Hong Kong's ICT sector (see Appendix 6 for full discussion). It represents the initial conditions for the constituency building process of the ICT cluster. The analysis is divided into two levels, 1) the general conditions of Hong Kong; 2) the specific conditions of the ICT sector.

Table 5.1 Application of the NSI/IC framework to assess Hong Kong's ICT cluster

| |
|---|
| **1. Factor conditions/institutional set up of financial sector**<br><br>**a. Hong Kong**<br>• Hong Kong is small economic region in terms of population and GDP. The government invested heavily on public education and its population possess high education levels.<br>• Hong Kong has excellent physical infrastructure both in transportation and communication, but lack of appropriate infrastructure for technology development (e.g. no science park until 1999)<br>• Hong Kong has the second largest financial market in Asia. However, VCs rarely invest in Hong Kong technology companies and the GEM board has poor performance<br>• The government introduced a number of funding schemes to help technology start ups, but their impact is limited.<br><br>**b. ICT sector**<br>• ICT industry is of major importance to Hong Kong's economy. It is the largest export of the territory<br>• Hong Kong's traditional ICT manufacturing industries experience a decline due to competition from other low cost economies, the government tried to encourage the industry to develop high value added ICT products<br>• Hong Kong's ICT sector is dominated by SMEs, they are constrained by limited technological and financial capabilities<br>• Lack of raw materials and price advantages, ICT companies mainly import components from overseas<br>• Hong Kong has sufficient number of science graduates, but they are unwilling to work for the industries. Experienced engineers are small in number and high in cost. |
| **2. Demand conditions/role of public sector**<br><br>**a. Hong Kong**<br>• Domestic market is small, most of the products made in Hong Kong are exported to US and China<br>• Mainly followed non intervention policies, early government industrial policies included the development of three industrial estates and set up supporting organisations to help technology upgrading<br>• The political changeover in 1997 provided opportunities for Hong Kong government to directly engage in science and technology policies<br>• Before 1997, the Hong Kong government lacked a holistic strategy to support innovation and technology. Initiatives are piecemeal and not well communicated to the relevant stakeholders<br>• There is in general lack of demand for technology from the industries, particularly SMEs |

- Government is perceived as lacking commitment and determination to pursue long term technology development strategy
- Lack of a technology culture in Hong Kong. The government has been criticised for not having a thorough understanding of technology development

**b. ICT sector**

- ICT products made in Hong Kong are mainly for export, SMEs have difficulties in expanding their markets due to lack of proper technology management personnel
- The backward user-producer linkages are strong due to the adoption of flexible production methods to manufacture in China, but the knowledge flow is limited as the companies are based on labour intensive production
- The forward user-producer linkages are strong, ICT companies have high level of knowledge exchange with their customers
- Large system companies exist in Hong Kong, they produce both intermediate and final products for customers
- The government helps boost the software industry by acting as a main ICT user for the government computerisation and e-government campaign
- The government encourage the development of ICT industry by providing infrastructures, financial supports and favourable legal regimes

**3. Related and supporting industries/R&D intensity and R&D organisation**

**a. Hong Kong**

- Hong Kong's overall investment in R&D is very low (0.6% of the GDP) and behind many other countries in Asia
- The territory's research base is mainly at universities, but companies seldom engage in basic and fundamental research
- Most companies consider to a large extent, their customers and to a lesser extent, suppliers, as their source of innovation.
- They rarely consider universities as a major source of innovation and their linkages with universities are weak
- The major barriers to innovation are lack of resources and personnel to conduct R&D since Hong Kong industry is dominated by SMEs (98%)
- The other barrier to innovation is lack of an R&D organisation to conduct mid-stream research

**b. ICT sector**

- The majority of ICT companies do not have R&D functions as they are mainly engaged in OEM production
- There are only a small number of ICT companies in Hong Kong which have high technological capabilities

- Most SMEs are not technologically sophisticated enough to work in knowledge network with universities
- Most university spin out companies are newly emerged and very few of them can maintain profitability
- Hong Kong's ICT companies have little cooperation with universities except at the student level.
- Technology transfer offices began to appear in late 1990, but some of them are constrained by lack of human and financial resources
- Universities of Hong Kong produce high number of graduates in ICT, but many of them prefer to work in the business or banking fields
- Other barriers to industry-university linkages are mismatch between industry and academic research in terms of topics, speed of technology development and cultures.
- Academics lack motivation to engage in commercialisation activities since they are very well paid in Hong Kong

**4. Firm strategy, structure and rivalry/internal organisation of firms and interfirm relations**

**a. Hong Kong**

- Hong Kong's economic structure is largely dominated by the service sector (85%), while the manufacturing sector is experiencing a decline since 1980s
- SMEs (with less than 50 employees) represents 98% of the total number of companies in Hong Kong, medium sized and large companies (over 50 to over 500 employees) represent 2% of the total companies
- Most companies in Hong Kong are local companies, many of them are family run and have simple organisation structure
- Hong Kong's high cost structure (land and wages) is facing intense competition form other low cost economies
- Local companies tend to have good personal relationships and informal organisations are common in Hong Kong
- Entrepreneurial culture of Hong Kong is characterised by its 'short-termism', which is unhelpful to the new business rate for technology companies

**b. ICT sector**

- Some large Hong Kong ICT companies have local supply chains, but they also import components and materials from all over the world.
- Not much knowledge flow among ICT companies, there is no research consortia formed by local ICT companies
- Social network is strong, networking organisations are able to provide informal governance but the large number of networking organisations has diluted the number of their membership
- The birth rate of ICT companies is low due to high entry barrier and cost structure

- Interfirm relationships are strong in Hong Kong, but companies tend to exchange more knowledge with their customers than with their suppliers
- Small design companies pursue offensive technology strategy, but lack of funds hinder their expansion
- Large ICT manufacturing companies pursue dependent technology strategy, but in order to fend off the competition from other developing countries, they start to upgrade their technologies and engage in ODM production
- Each ICT company is specialised in a niche technological area, not much overlapping/complementary among each other. ICT companies in Hong Kong neither compete nor cooperate technologically.

## 5.2 Evolution of Hong Kong's technology cluster ('meso' level) over a longitudinal period of time (1996-present)

This section illustrates the actual constituency building process of the ICT cluster in Hong Kong at the 'meso' level (level 2). It is worth noticing that even though the Hong Kong Government put much emphasis on ICT, the constituency building process of Hong Kong at this level is more akin to the model of developing a national/regional innovation system or a general technology cluster[23], the technology focus on ICT only emerged a few years after the inception of the cluster strategy.

Similar to Chapter 4, the analysis of this section makes use of Molina's STC diamond of alignment and is basically divided into four stages: namely 1) From idea stage to constituency building stage (1996-1997); 2) the constituency building and momentum-generating stage (1998-1999); 3) the constituency development and growth stage (2000-2002); and 4) the constituency-declining and re-alignment stage (2003-present). The STC diamond is applied at the end of each stage to assess the state of alignment of the critical factors contributing to the success and failure of the constituency building of the Hong Kong technology cluster.

**Early attempts of Hong Kong in cluster building**

Hong Kong had been a colony of Britain for 150 years. Before the return of sovereignty to China in 1997, the colonial British government mainly pursued a *laissez-faire* approach to Hong Kong's economic and industrial policies and did not make any explicit effort to nurture

[23] This section uses the term 'technology cluster' to refer to the national/regional innovation system or high technology constituency in Hong Kong prior to the setting of ICT as the technology focus.

any particular industry. The early attempt for the Hong Kong Government to help industrial development was setting up a quasi-government organisation, namely the Hong Kong Productivity Council in 1967 to help improve industrial productivity and promote the use of technology in production.

As mentioned in the earlier section, the manufacturing sector of Hong Kong began to experience a decline since the 1970s. To save the manufacturing sector, the industry members began to request support from the Government. In 1977, the Hong Kong Government formed a Committee on Diversification to look for ways to help the manufacturing industry. The Committee released a report in 1979, namely the *Report of the Advisory Committee on Diversification,* which proposed a number of ways to help enhance the 'diversification' of the manufacturing sector, such as encouraging industrial R&D and providing infrastructures. These recommendations, however, were not adopted by the Government. In 1978, China began its Opening policy and many Hong Kong manufacturing companies decided to move to China to tap into the low cost of land and labourers there. As a consequence, the manufacturing companies of Hong Kong continued their low value added production in the mainland and remained in their technological trajectory.

In the late 1990s, the non-intervention policy of the Hong Kong Government began to change. It was caused by the economic competition from both high-technology and low-cost competitors.[24] According to Martinsons (1997), in 1990, the Government appointed a private consultancy firm, BIS Mackintosh Limited to conduct a review of Hong Kong's ICT environment and manpower needs. The report by the consultancy firm particularly highlighted the neglect of the soft infrastructure for technology development in Hong Kong. To rectify the situation, the Hong Kong Government decided to set up a number of public funds with an aim to promote commercial R&D and to nurture the growth of technology-based enterprises.[25] The three main funding schemes are listed below:

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[24] As mentioned before, on one hand, Hong Kong had substantial competitive threats from other Asian Dragons which have developed highly successful high-tech industrial sectors since the 1980s. On the other hand, Hong Kong's OEM manufacturing faced fierce competition from other low cost Asian countries which constantly pulled down the profit margin of Hong Kong companies. Also, the increasing quality demand from overseas customers forced Hong Kong manufacturers to increase the knowledge content of their products.

[25] It should be noted that the technology related policies were targeted to all sectors and not only to the ICT sector, as the Hong Kong Government used to avoid the 'winner picking' approach.

Table 5.2 List of government funds for promoting the technology development of Hong Kong in the early 1990s (source: Report of Commission on Innovation and Technology, 1998)

| | |
|---|---|
| Industrial Support Fund (ISF) | Established in 1994, the ISF finances projects which are beneficial to the development of Hong Kong's manufacturing industry and technology in general. |
| Services Support Fund (SSF) | Established in 1996, the SSF finances projects which are beneficial to the development and competitiveness of Hong Kong's service industry, such as projects in relation to wholesale and retail, tourism and profession services. |
| Applied Research Fund (ARF) | Established in 1993, ARF provides venture capital for technological ventures or R&D activities that have good commercial potentials to local firms or their non-local partners. |

Apart from the provision of 'soft infrastructure', a group of industrial leaders and prominent academic[26] also lobbied the Government to provide physical infrastructure to support industrial technology development. More specifically, they requested the Government to construct a science park for technology companies. In 1992, the Government appointed an international consultancy company, Segal Quince Wicksteed Ltd to conduct a feasibility study on the construction of a science park. Although the report (unpublished) came out in the same year recommended that a science park should be built, the Government did not approve the plan, apparently due to the large financial and land commitment required for the project. (Wong in Ji, 2002)

However, the Hong Kong Government decided to construct a science park-like building to put the idea to test. In 1993, the Government provided a grant of HK$250 million to fund the construction of a modern building, namely the **Industrial Technology Centre** (now renamed Inno Centre) in Kowloon Tong, in close proximity to the Hong Kong Productivity Council and the City University, based on the concept of clustering[27]. The Government also launched

[26] The group of people who lobbied the government included Raymond Chien (Chairman of Industry and Technology Development Council), Professor Charles Kao, (former Vice Chancellor of the Chinese University of Hong Kong), C. D. Tam, (former Executive Vice President of Motorola Inc.), and Allen Wong (chairman of VTech Group of Companies).
[27] The Government intended to create a high tech cluster in Kowloon Tong—the 'Silicon Tong', by encouraging MNC and local technology companies to agglomerate at the Industrial Technology Centre and to facilitate their interaction with City University and HKPC which located in the same area.

an incubation programme to foster indigenous technology companies in the Industrial Technology Centre.[28]

The Industrial Technology Centre and its incubation programme proved to be a success, at least before 1997. The Centre attracted international technology companies such as Philips and Oracle as tenants. About 70 companies have graduated from the incubation programmes and the survival rate of these incubated companies was about 80%, roughly comparable to similar programmes run in the US. The success of the Industrial Technology Centre encouraged the Government to re-consider the plan to build a large scale technology cluster. In 1995, the Government initiated the second feasibility study for the construction of a science park. The report, completed in 1996 (unpublished), reaffirmed the need for a science park for Hong Kong and clearly articulated its strategic importance:

> '*A key conclusion of both the stage one and two studies is that a science park could play a central catalytic role in supporting technology development and transfer in Hong Kong, thereby contributing substantially to the Territory's role as a control centre for manufacturing and services for southern China and the East Asian region.*' (Segal Quince Wicksteed, 1996, p.2)

Although a favourable atmosphere was generated for the constituency building of a technology cluster in Hong Kong, unfortunately, the Government of Hong Kong did not seize this opportunity to introduce large scale technology policies, due mainly to two reasons; firstly, Hong Kong was on the eve of political changeover and the strained relationship between the British and Chinese governments caused by the prolonged political arguments inhibited the introduction of any new large scale policy programmes before the changeover; secondly, according to Sum (2002), during that period (around 1996) different interest parties in Hong Kong embarked on vigorous debates over the future strategy that Hong Kong would have to pursue after 1997. Whilst the manufacturing faction supported the development of technology to rejuvenate the industrial sector, the services faction pressed the notion of strengthening the service sectors to develop Hong Kong into a service hub in Asia. Backed by different interest parties and government leaders, the dispute could not be resolved, thus delaying the introduction of large scale technology policies in Hong Kong.

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[28] Technology start ups admitted to the three-year incubation programme were entitled to a number of benefits, including a rental discount up to 70% of the market rate for office space in the Industrial Technology Centre, financial support in the form of low interest loans and accession to the technology transfer and R&D supporting programmes offered by the local universities.

### 5.2.1 Period 1—Birth of the Hong Kong technology cluster
### From the 'idea' stage to constituency building stage (1996-1997)

**The MIT report and the importance of information technologies**

On the eve of the political changeover, the wish to pursue a technology development path in Hong Kong had been voiced out by some industrial leaders. In 1996, the Government and a number of industrial trade associations, such as the Federation of Hong Kong Industries and Chinese Manufacturers Association of Hong Kong, sponsored a research team at Massachusetts Institute of Technology (MIT) to conduct a comprehensive study on the manufacturing sector of Hong Kong[29].

The research report, entitled *Made by Hong Kong*[30] was published in 1997, warned that the low cost manufacturing model of Hong Kong by making use of the cheap labour in China, would be unsustainable, due to the rising labour and land costs in Guangdong province and the fierce competition from other Asian economies, such as Japan who organised its own production networks in China. The best way to save the Hong Kong's manufacturing sector was '*to move the "Made by Hong Kong" industrial system into* ***the manufacture of innovative products and processes incorporating new information technologies*** *and join them to Hong Kong firms' traditional skills as flexible and rapid manufacturers.*' (Berger and Lester, 1997, p.97)

To achieve the above, the MIT research team proposed a number of strategies to strengthen Hong Kong's technological capabilities. These are:

1) To acquire technologies from outside, through attracting technology MNCs to Hong Kong and cooperating with China;
2) To strengthen Hong Kong's R&D base by encouraging university-industry linkages and establishing public research institutes;
3) To invest in education, training and human resources development
4) To foster entrepreneurship and provide funding for technology start-ups, encouraging to them agglomerate in a physical or virtual space;
5) To strengthen the government's own technological capabilities.

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[29] The MIT team had previously studied the American industrial performance and published a famous book entitled *Made in America*. The research done by the MIT team in Hong Kong covered the micro and macro levels of Hong Kong's manufacturing sector and about 400 organisations in Hong Kong and China were involved in the study.

[30] *Made by Hong Kong* refers to the products manufactured by Hong Kong, owned and/or managed enterprises wherever they are located, in contrast to the products made 'in' the territory of Hong Kong. (Berger and Lester, 1997, p.xii)

In addition, the MIT report highlighted the importance of information technologies for Hong Kong. The research team not only praised the global competitiveness of Hong Kong's electronic industry but also identified the ample opportunities for Hong Kong to emerge as an international supplier of software, information services and electronic commerce. Quoting the words from the report:

> '*The importance of information technology to Hong Kong's efforts to raise industrial productivity and performance has been a pervasive theme of this report. We have commented on the central role of information technology in the design, manufacture, and delivery of the service-enhanced products of the future. We have also stressed the importance of information technology to upgrading the performance of Hong Kong's service industries, including transportation, trade, telecommunications and financial services, the fortunes of which are ultimately tied to the production networks of 'Made by Hong Kong*'. (Berger and Lester, 1997, p. 108)

Pursuing the above mentioned strategies to strengthen Hong Kong's technological capabilities would also help deal with the threats and opportunities of the ICT trends shown in Table 5.3:

Table 5.3 Technology context for the development of the Hong Kong technology cluster, with a focus on ICT

| |
|---|
| **1. Commodification of ICT products made by Hong Kong**<br>The success of Hong Kong's ICT industry was based on its high volume, commodity manufacturing of ICT products, in particular the consumer electronic products. However, the commodification of these products means that the technology will become mature and obsolete. Hong Kong's ICT companies have to respond to this trend by launching new products quickly and making sure their supply chain companies in China can catch up with the shortened market window. |
| **2. Increasing complexity of ICT products**<br>For ICT products, regardless of whether they are for domestic or industrial use, the product itself is getting more complex and customers demand more functions embedded in one piece equipment. Many new ICT products are constructed by a confluence of a variety of technologies or blending different ICT products together (such as multi-media). |
| **3. Increasing networking among ICT companies**<br>The growing complexity of ICT products demands a mix of a complex variety of technologies. Since one company cannot master all the technologies, it is a common trend for ICT companies to seek technology partners. However, most international companies do not regard Hong Kong as their first choice since there are very few centres of excellence in Hong Kong and Hong Kong ICT companies have very little to offer technology-wise. |
| **4. Increasing need for inter-operability**<br>Since ICT products need to be kitted or bundled with other technologies/products to make one final piece of equipment, the 'inter-operability' among different ICT products becomes an important |

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| dimension for ICT companies. For example, ICT prototype design needs to match the specifications of other parts of the equipment, and software design also needs a compatible platform to perform its functions. This reinforced the need for closer networking and communications among different ICT companies. |
| **5. Increasing R&D and capital intensity**<br>In association with the increasing complexity of the ICT products is the growing R&D intensity and capital requirement for the ICT companies. This is a negative trend for Hong Kong ICT companies, as they have a low level of R&D capability and are constrained by limited financial resources to invest in R&D. This requires the government to invest in infrastructure to lessen the burden on the ICT companies. |
| **6. Asia/China emerging as the global largest ICT market**<br>Asia, in particular China has been regarded as the largest emerging market for ICT products and many international ICT companies have the target to penetrate to the Chinese market. Hong Kong is well positioned to reap the benefit of this trend as many Hong Kong ICT companies possess the skills for marketing and manufacturing in China. They can also make use of their 'aesthetic design' and 'applied design' skills to help many MNCs to localise their products for the Chinese market. |

### The Asian Financial Crisis[31] and the burst of the stock and property bubbles

The MIT report did provide a strong case for the post-colonial Hong Kong Government to pursue technology development, but what really drove it to take action was the outbreak of the Asian Financial Crisis and subsequent the burst of the stock and property bubbles in Hong Kong.[32] The Asian Financial Crisis exposed Hong Kong's structural weaknesses of over dependency on the service and property sectors and lack of manufacturing in the territory. To solve the structural problems of Hong Kong and to regenerate the economy after the financial crisis, the Hong Kong Government sought to build a technology cluster by launching a series of high technology policy programmes.

[31] The Asian Financial Crisis was caused by speculators' attack on the Thai bhat in February 1997. The Bank of Thailand allowed the bhat to float on 2 July 1997 and triggered a financial contagion that spread from Thailand to Indonesia, Malaysia, South Korea, Philippines and then Hong Kong. The discussion of the general Asian Financial Crisis is beyond the scope of this thesis, this section only focuses on the crisis's impact on Hong Kong.

[32] After the outbreak of the Asian Financial Crisis in February 1997, Hong Kong's currency was under speculative attack in July, August and October of the same year. The Hong Kong Government maintained its pegged exchange rate (US$1: HK$7.78) by raising the interest rates to 300% in October 1997. As a result of this, the stock market index dropped from its peak of 16000 points before the political changeover, to just above 8000 points at the end of the year. The high interest rate also led to reduced demand for residential property and caused the property price to drop over 50% from its height in 1998.

After the political changeover, the First Chief Executive of Hong Kong announced its first *Policy Address*[33] in October 1997. He clearly pointed out that Hong Kong was facing challenges in the knowledge-based economy due to the erosion of its traditional competitive advantages. One of the important ways for Hong Kong to maintain its competitiveness was to upgrade its industries and services to high value added ones, through innovation and technology development. He declared a new vision to make '**Hong Kong an innovative centre for South China and the region**'. His speech articulated this vision as follows:

> *'…. **My aim is to make Hong Kong an innovation centre not just for ourselves, but for South China and the region**, adding value to our economic hinterland, from which in turn we draw benefit…'* (Information Services Department, 1997)

In accordance with the above vision, a number of key initiatives were proposed, including 1) to allocate land for the construction of a Science Park in 1998; 2) to develop a second industrial centre and a fourth industrial estate; 3) to inject HK$500 million for the Applied Research Fund, and 4) to set up a HK$500 million Credit Guarantee Scheme to help SMEs. (Information Services Department, 1997) The first Chief Executive's declaration marked the official beginning of the constituency building process of Hong Kong's technology cluster.

Table 5.4 Overview of state of alignment at the end of the 'birth' stage of Hong Kong technology cluster

| **Overview of initial state of alignment of Hong Kong's ICT cluster by 1997** |
|---|
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• The technology cluster constituency building process was originally initiated by both the government and a few industrial leaders, who witnessed the decline of manufacturing sector and sought ways to save Hong Kong's industrial competitiveness. However, the colonial Government was not committed to the process and was unwilling to carry out large scale actions due to the potential violation of the 'non-intervention' tradition. The early attempts only achieved limited success, but it opened a space for government discussion on launching technology policies and paved the way (or prepared some of the constituents) for the constituency building process of the technology cluster after 1997.<br>• By 1997, the government and industry leaders succeeded in aligning the MIT research team to produce an authoritative report to support the idea. The report recommended pursuing a technology development route and identified ICT as one of the important technology areas |

[33] *Policy Address* is a document which outlines the Hong Kong Government's overall direction and strategies for that particular year. It is normally released in association with the *Policy Objectives*, a document which spelled out the specific policies and initiatives carried out in accordance with the government strategies.

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| to develop. The report convinced the new Chief Executive and at the end of this stage, technology development became an official policy of the SAR government. The new SAR Government prepared to commit huge resources to carry out a large scale action to make Hong Kong 'an innovative centre for Southern China and the region.' |
| **(II) Nature and Maturity of the Technology**<br>• The technology at the centre of the effort to build a cluster was both wide ranging and challenging since it concerned the upgrading of Hong Kong's OEM based, low value added manufacturing industries to knowledge intensive and high value added ones. In particular, the competitiveness and potential of Hong Kong's electronic and information technology industries had been emphasised by the MIT report and called for special attention and nurturing efforts on the part of the Government. |
| **Alignment (1) Governance**<br>• By 1997, the build up of a high tech cluster became an official policy in Hong Kong. This favourable governance was caused by the Asian Financial Crisis which exposed Hong Kong's structural weakness and caused much economic turmoil. This impelled the Government to look for a fresh approach to re-generate the economy.<br>• The market governance lent support to the idea that Hong Kong had to avoid over-dependence on the service sector and needed to upgrade its manufacturing sector to produce more knowledge intensive and high value added items so as to maintain the territory's competitiveness in the region.<br>• However, the favourable government and market governance were not enough to secure the upgrading process. Their positive effect was counteracted by, on one hand, Hong Kong's lack of high tech manufacturing sector and the low R&D capability of the existing manufacturing sector. On the other hand, the economic disaster caused by the Asian Financial Crisis, particularly the collapse of financial and property markets called for a quick fix from the Government, and apparently, the fostering of a technology cluster was a long-term development and was unable to meet the public's most urgent and immediate needs. |
| **Alignment (2) Nature of Target Problem**<br>• The problem faced by the technology-cluster constituency building process was massive and complex due to the fact that a knowledge-based manufacturing sector has never existed in Hong Kong. That means the Government had to make a huge effort in transforming the traditional manufacturing sector from a matured, low-value added, low technological capability sector to an innovative, knowledge-intensive, high value added one. This also implies a need to transform the structure and the governance of the manufacturing sector, including the encouragement of industrial R&D investment, strengthening industry-university interaction and fostering an entrepreneurial culture.<br>• It also means responding more effectively to the technology trends described in Table 5.3. |

These are :

1. Commodification of ICT products made by Hong Kong
2. Increasing complexity of ICT products
3. Increasing networking among ICT companies
4. Increasing importance of ‘inter-operability’
5. Increasing R&D and capital intensity
6. China emerging as the largest global ICT market

- It is doubtful whether the SAR government has the competence to lead the technology cluster constituency building process. Not only did this violate the traditional ‘non-intervention’ principle of Hong Kong, but also the new SAR Government did not have any experience in launching large scale industrial and technology policies.
- The Hong Kong society was troubled by the problems caused by the Asian Financial Crisis, the introduction of high technology policies was unable to meet the need of the society at that time which needed a quick change to re-generate the economy.

**Alignment (3) Target Constituents’ Perceptions and Pursuits**

- At the end of the ‘idea’ stage, the technology-cluster constituency building process had almost everyone as its target constituents. The cluster approach was very new to Hong Kong and the SAR Government needed to invite a wide range of organisations to join the cluster, including foreign and local technology companies, universities and research institutes, financial organisations and other government departments.
- However, it was uncertain whether the target constituents were willing to support the government’s vision and get involved in the constituency building process. The government had to change the original mindset of these people. The financial sector had to invest in technology start up, universities to collaborate with industry and industry to innovate. Also, some target constituents were outside Hong Kong, e.g. MNCs and talents from China. This required extra effort from the Government to align them with the constituency building process.

**Alignment (4) Interacting Technologies/Constituencies**

- The consensus for the constituency building of a technology cluster was low in Hong Kong. In particular, the service sector constituency had another proposal and wanted the Government to uphold the service sector. It raised opposition and weakened public support for the new technology cluster.
- Inside the constituency, the range of technologies was very wide and at this ‘idea’ stage, the SAR Government lacked a clear focus as to which technologies to support in their development, although the MIT report highlighted the importance of ICT. This led different technology sub-sectors to compete with each other. This also confused the public, and even the (potential) participant organisations of the technology constituency.
- The building of a technology cluster focussing on ICT involved a better integration of the ICT sector along the value chain, which conceived design, manufacture and distribution of

ICT parts and end products. This also implied greater interaction with other ICT sub-sectors, such as software, e-commerce and other information services, or even with the service sectors, such as the service, finance, transportation and tourism.

### 5.2.2 Period 2—Growth of the Hong Kong technology cluster

**Putting Vision into Actions (1998-1999)**

**1. Mapping Hong Kong's technological environment**

The first step taken by the SAR Government to realise its 'high tech' vision was to commission a piece of research to map out the general technology environment of Hong Kong, and identify the measures needed to be taken. In 1998, the Chief Executive Chee Hwa Tung appointed a Commission on Innovation and Technology, led by prominent scholar Professor Chang Lin Tien to conduct the mapping exercise.[34] Two reports came out, one in 1998 and one in 1999. Both confirmed the need for Hong Kong to introduce technology policies and laid out the overall strategies that Hong Kong should take to realise its vision.

The 1998 Commission report identified six major weaknesses of Hong Kong's technology sector and their conclusions were similar to the findings of the MIT report. Summing up, the 'target problems' implied in the build up of Hong Kong's technology cluster were:

1) Hong Kong companies were weak in the development of technologies. They tended to avoid investing in technologies due to the long pay-off period. Technology entrepreneurs were underrepresented in Hong Kong;
2) Hong Kong was short of quality research scientists and engineers in the industry and showed a lack of skills in the management and transfer of technologies;
3) Venture capital funds were more likely to target mature companies, while start up technology companies have difficulties in raising seed capitals to commercialise their ideas;
4) The collaboration between industry and university was rare;
5) There were abundant technology resources in mainland China but Hong Kong companies have not yet exploited them;

[34] Professor Tien was the Chancellor of University of California, Berkeley in the US and a member of the US President Bill Clinton's National Science Board. The Commission invited about 300 individuals, public and private organisations, to give their views through numerous interviews, visits and workshops.

6) Hong Kong did not have a 'high tech' image and had a poor technology culture (Central Government Offices, 1998, p. 24-25)

The 1998 Commission also clearly articulated that:

*'The vision of making Hong Kong an innovative centre for the region is a* ***timely response*** *to the challenges…Under this vision, Hong Kong would be an innovation-led, technology-intensive economy in the 21st century, serving the region not only as a business and financial centre, but also a centre for the development and commercialisation of innovative ideas and technology'* (Central Government Offices, 1998, p.13)

**2. Identifying the technology focuses**

The 1998 Commission report also stressed that Hong Kong's technological development should be based on its traditional strengths, and specifically, its ICT industry. As written in the report:

> '*We wish to highlight the strategic importance of and opportunities offered by* ***information and communication technologies****. They are important not only as high growth and fast-developing industries per se, but are also key enabling technologies for adding value to other industries*.' (Central Government Offices, 1998, p.22)

Yet, ICT was not the only focus of the Commission, they also identified many other technological opportunities for Hong Kong to pursue, such as

- *a leading city in the world for the development and application of information technology, especially in electronic commerce and software engineering;*
- *a world class design and fashion centre;*
- *a regional centre for multimedia-based information and entertainment services;*
- *a world centre for the development of health food and pharmaceuticals based on Chinese medicine;*
- *a leading international supplier of high value-added products and components in areas where Hong Kong already excels today;*
- *a regional centre for supplying professional and technological talents and services; and*
- *the market place for technology transfer between the Mainland and the rest of the world.* (Central Government Offices, 1998)

In fact, their broad-brush approach actually planted the seeds of at least three problems for Hong Kong's constituency building of the technology cluster. First, it confused the public in relation to which technology the Government wanted to pursue; second, it generated difficulties for the Government, in particular in the financial aspect, given the apparent need to support and develop many technology areas at one time; third, among all the technology opportunities identified by the Commission, Hong Kong only had strength in some areas, such as ICT. For those areas that Hong Kong did not have a true competitiveness, such as pharmaceuticals, the effort to create constituency building processes would be far more difficult.

### 3. Designing key strategies and policy programmes

To achieve the vision of turning Hong Kong into '*an innovation centre for South China and the region'*, the Commission report proposed several strategies to address the weaknesses of Hong Kong's technology cluster. They are listed in Table 5.5:

Table 5.5 Key strategies for the constituency building of the technology cluster of Hong Kong (source: Report of Commission on Innovation and Technology, 1998; 1999)

| **Sub-areas** | **Key strategies** |
|---|---|
| Technology infrastructure | • Strengthen technological infrastructure and promote technological entrepreneurship |
| Human resources | • Build up human capital to meet the needs of the knowledge-based economy (by cultivating manpower for technology development and attracting technological talents to Hong Kong) |
| Collaboration with China | • Enhance technological collaboration with the Mainland |
| Industry-university linkages | • Foster university-industry partnership; |
| Innovative environment | • Lower information, financing and regulatory barriers, foster a culture of innovation and technology in industry, maintain a conducive business environment |

Although it was not spelled out explicitly, the theoretical concept behind the above strategies was very much alike the concept of 'clusters' or 'innovation systems'. To pursue the constituency building process of the Hong Kong technology cluster, a number of policy programmes were designed in accordance with the key strategies. Examples of these programmes are listed in Table 5.6

Table 5.6 Summary of the Hong Kong Government's action plans for developing the technology cluster in 1998-1999 (Source: Report for Commission on Innovation and Technology, 1998; 1999)

| **Action Plan for the Hong Kong Innovation System in 1999** |
|---|
| *Strengthen technological infrastructure and promote technological entrepreneurship*<br>• To establish an Innovation and Technology Fund with an initial injection of HK$5 billion to meet requirements in the short to medium term<br>• To introduce a HK$500 million funding scheme to assist small entrepreneurs undertaking commercial R&D work at the pre-market launch stage<br>• To expand the government's incubator programme through a distributed model<br>• To set up a co-investment scheme providing government venture capital on a matching basis with private funds.<br>• To construct a science park to help attract overseas technology firms to Hong Kong and stimulate the growth of local technology businesses |
| *Build up human capital meeting the needs of a fast changing, knowledge base economy*<br>• To establish a publicly funded applied science and technology research institute to assist commercialisation of scientific research results<br>• Government continues to invest heavily in education, paying special attention to creativity, communication skills and information technology, to inspire interest in science and technology among young people, and to foster a culture of lifelong learning among the workforce<br>• To step up the Government's overseas liaison and promotion efforts in major technology centres such as the Silicon Valley, targeting especially at Chinese talents and technology entrepreneurs<br>• To relax immigration restriction on Mainland talents. Mainland talents should be admitted quota-free and be allowed to bring along their immediate family members, mainland students in local universities should be permitted to work in Hong Kong after graduation. |
| *Enhance technological collaboration with the Mainland*<br>• To establish a comprehensive data base of mainland technological resources<br>• To establish a collective mechanism for liaison with relevant industrial support bodies in the mainland at both the central and regional government levels<br>• To encourage cooperation with the mainland in the area of technological support infrastructure, including joint R&D, upgrading HK firms in the Pearl River Delta, technological exchange between universities, easing cross-border travel for research scientists and engineers |
| *Foster university-industry partnership;*<br>• To encourage universities to set up task forces to coordinate publicity on research and a |

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| central database for their research resources<br>• To encourage universities to establish a system of industrial sabbatical and allow staff to take unpaid leave for technology-transfer work<br>• To introduce a package of incentive schemes to promote university-industry partnership<br>• Encourage universities to promulgate a clear promotion policy recognising researchers' efforts in commercially relevant work<br>• To allocate HK$250 million from the ITF for a matching grant scheme for private companies undertaking commercial R&D work in collaboration with local universities and for other funding schemes promoting university-industry partnership<br>• Government to consider organising sector-specific events, involving industry and academia to develop action agendas for individual industries or industry clusters |
| *Lower information, financing and regulatory barriers*<br>• To maintain Hong Kong's appeal as an attractive place to live and work<br>• To attract multinational companies to use Hong Kong as a regional hub for application or service support and development, and as a base for R&D catering for the Asian market<br>• Maintain Hong Kong's business-friendly environment and be vigilant in promoting competition<br>• Continue to combat vigorously infringements of intellectual property rights |

**4. Promotion of ideas and mobilising key players**

Although the 1998 Commission Report stressed that to turn Hong Kong into a centre of innovation would demand '*sustained and concerted effort from industry, the academia, the Government and the community at large*' (Central Government Offices, 1998, p.23), when the Chief Executive first proposed the 'high tech' vision in 1998, the idea was not immediately accepted by the general public. They doubted whether this vision was a correct one for Hong Kong to pursue. For instance, opponents in the service sector argued that Hong Kong should develop into a 'business/service/financial' hub[35] (Sum, 2002), whilst the local newspapers published articles to list out many problems that would obstructed Hong Kong's move to a high tech road, such as:

> *'The problems include inadequate supply of well-trained IT personnel, poor showing in original technology production, lack of SME sector, and Hong Kong's business culture of looking only at the short-term perspective…'* (Hong Kong Standard, 25 November, 1998)

[35] According to Sum (2002), such a view was proposed by Harvard Business School consultants in a report entitled *Hong Kong Advantage* (Enright et al., 1997) sponsored by the Vision 2047 Foundation which represented the commercial and financial sector's interests. Interestingly, this report also proposed to promote the development of 'clusters' for key service sectors.

Besides, other countries in the Asia Pacific regions had already embarked on their technology programmes in the 1980s. The Taiwanese Government announced their vision to develop a 'high-tech island', whilst the Singapore Government also had a similar plan to build an 'intelligent island'. In addition, China has constructed science and software parks in almost every city, and countries like Thailand, the Philippines, Malaysia and India were doing the same thing. Many people in Hong Kong generally thought that it was too late to catch up with other Asian countries.

In order to seek to align the divergent views, the Chief Executive repeatedly called the public's attention to economic problems brought by the Asian Financial Crisis and the importance of innovation and technology to Hong Kong's economic development in his Policy Address and public speeches[36]. The following statements were frequently made in numerous occasions:

> *'The financial turmoil has not only rocked our company, it has also exposed inherent weaknesses in Hong Kong's economic structure…At present, our economy is in a difficult period of adjustment. But this adjustment is necessary because it will help us to improve our competitiveness.'* (Information Services Department, 1998)

> *'Innovation and Technology are important drivers of economic growth. In a knowledge-based global economy, they are essential in adding value, increasing productivity and enhancing our overall competitiveness…'* (Information Services Department, 1998)

> *'Innovation and technology are the major driving forces of economic growth...'* (Information Services Department, 1999)

Following the frequent emphasis by the Chief Executive, and senior government officials, it seemed that the general public began to recognise the importance of innovation and technology to Hong Kong's competitiveness and gradually accepted Hong Kong's 'high tech' vision. The 1999 Commission Report pointed out a change in the public's perception as follows:

> *'The past year has seen a change from scepticism to general acceptance in the public mood about the importance of innovation and technology to Hong Kong's competitiveness. The focus of debate has shifted from whether Hong Kong should pursue such a course to how it should be carried forward…'* (Central Government Offices, 1999, p iii)

[36] Also see Chief Executive's speeches at the Symposium on Commercialisation of Innovation and Technology (Information Services Department, 16 October, 2000b), Opening Ceremony of Hong Kong Science Park (Information Services Department, 27 June, 2002c); Secretary Commerce and Industry's speech at the Opening Ceremony of the XIIth World Productivity Congress (Information Services Department, 6 November, 2001e).

**Mobilisation of key target constituents**

Besides, in order to promote Hong Kong's new 'high tech' vision, in 1999, the Chief Executive paid a visit to high tech countries like Israel and the US. He met the local industry leaders and introduced the new initiatives of Hong Kong to help technology development. In particular, he announced that Hong Kong was going to construct its Science Park and invited overseas technology companies to locate there. His trip also helped initiate the linkages between Hong Kong companies and the Chinese community in America's Silicon Valley. After his visit, the Government set up the Hong Kong Silicon Valley Association and created a new website, namely Hong Kong-SV.com in 1999 to promote collaboration between Hong Kong and Silicon Valley.

Regarding the local companies, some senior government officials proactively approached the leading technology companies and persuaded them to become the anchor tenants of the Science Park. With its proactive promotion efforts, eight technology companies showed their support to the Government's new vision by signing the tenancy agreement to be the anchor tenants of the Hong Kong Science Park. In addition, the Government also engaged the academic community of Hong Kong to take part in the technology cluster. In 1999, a Memorandum of Understanding was signed between the Hong Kong Science Park and six local universities. The agreement included collaborating in research and development; initiating student training programmes and sharing of facilities. (Hong Kong Science Park, 2000)

**5. First crisis of the constituency-building process of Hong Kong's technology cluster (1999)**

**The Cyberport Project**

After the Government announced its high tech vision, some local companies responded positively to it by putting forward their proposals for various 'high tech' projects. One high profile project was called the 'Cyberport', a piece of infrastructure constructed under the concept of 'clustering'[37]. 15 leading international IT companies, including Cisco, Microsoft, IBM, Oracle, HP and Yahoo and about 150 local and overseas IT companies indicated their

[37] The 'Cyberport' project was proposed by Richard Li, the son of a local property development tycoon, and his corporation, Pacific Century Cyber Works (PCCW) in June 1998.

interest of becoming tenants of the Cyberport. In addition, a Cyberport Institute will be developed to run training course in cooperation with some major ICT companies.[38]

To support the Cyberport project, the Government agreed to allocate a piece of land in Telegraph Bay of Po Fu Lam, near the University of Hong Kong, valued at approximately HK$7.8 billion, for free, for the construction of the Cyberport. Despite the high profile support from the Government, the project was disliked by many other property developers, who were excluded from it.[39] Besides, the Cyberport project was heavily criticised by the media as 'a real estate project in high tech disguise'. Quoting the words from a news article in 1999:

> *'The euphoria surrounding Cyberport is due to the assumption that you put in a lot of infrastructure— then things will happen. One worries that we are putting the cart before the horse. Malaysia has a multimedia corridor with similar anchor tenants—big international names—enjoying cheap rents. But nothing seems to have come out of that. If the Cyberport is going to be another multimedia corridor, we don't know how much of use it is going to be'.* (Hong Kong Standard, 9 June, 1999)

**6. Initial launch of 'high tech' initiatives and building of momentum (mid-late 1999)**

In spite of all the criticism, in mid 1999, the Government began to move forward with the initiatives in support of the development of the technology cluster. In June 1999, the Government launched the HK$ 5 billion **Innovation and Technology Fund (ITF)** to replace the ISF and SSF as the major funding for projects in relation to innovation and technology upgrading of both manufacturing and service sectors. A matching grant of HK$250 million from the ITF was allocated for promoting university-industry collaboration in late 1999. Besides, the three professional venture capital firms that had been appointed in late 1998 as the managers for the HK$750 million **Applied Research Fund (ARF)** began to invest in a few Hong Kong technology start-ups. In October 1999, the Hong Kong Stock Exchange launched the **Growth Enterprise Market (GEM),** which was Hong Kong's version of Nasdaq, offering an alternative listing choice for technology companies. With the creation of a number of institutional constituents, Hong Kong's efforts to advance towards a knowledge-based technology cluster began to acquire momentum.

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[38] Partner companies include Cisco, Hewlett Packard, IBM, Microsoft and Oracle. These five founding partners would contribute to the curriculum development, coursework and job placement for students of the Cyberport Institute.

[39] Three times, ten leading property developers of Hong Kong jointly wrote petition letters to the Financial Secretary and lobbied the legislators to terminate the appropriation of public fund for the project. (Ming Pao, 26 January, 2005)

**Momentum building stage**

The above programmes implemented by the Government had an impact on the wider society and it seemed that a high-tech 'hype' has been generated in Hong Kong. Companies from different sectors demonstrated their support to the Government's new vision by introducing their 'high tech' business plans. For example, a large property developer, Sun Hung Kai Properties (SHKP) announced in August 1999 a 'Cyberincubator' project[40]. The company transformed its empty old industrial building to provide rent-free space for new 'infopreneurs' for three years, in return for 10% stakes in their respective businesses.[41] In addition, Techpacific, a venture capital firm, had earmarked US$5 million for an investment called Tp Labs, which was a 21,000 square foot incubation centre for technology start-ups to use as their initial office space. In return, Tp Labs took at least a 25% stake in them when it provided seed capital. (South China Morning Post, 21 September, 2000)

To take advantage of the favourable atmosphere created for the development of the technology cluster, in November 1999, the Chief Executive proposed another technology project called 'Herbal Port'. In 1999, an Institute of Chinese medicine was set up with the financial backing of HK$500 million donation from the Hong Kong Jockey Club. The aims for setting up the Institute were to promote the standardisation of traditional Chinese medicine and to develop Chinese medicine that would be accepted by overseas health authorities. The Government also set a target to set up the regulatory framework and a data base for the industry in 2000 and 2002, respectively. (Hong Kong Standard, 14 November, 1999) The Herbal Port project attracted the interest of the private sector. For example, the Chung Wei Medicine Group planned to invest HK$16.3 billion to build the Herbal Port at Ma Wan. Another company, New World Life Tech, also proposed a HK$20 billion Chinese medicine port project. (Hong Kong Standard, 14 November, 1999)

In short, the technology cluster had generated positive signals that effectively changed the public's mindset. The Commission on Innovation and Technology summarised the change of atmosphere of Hong Kong towards the 'high tech' vision in 1999 with the following statement:

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[40] The Cyberincubator project operated in cooperation with the Government's Industrial Technology Centre as part of its incubation programme. However, the project did not achieve much success as expected. Only six technology start ups have joined the scheme since its introduction in August 1999. (South China Morning Post, 22 June, 2001)

[41] Sun Hung Kai also set up an internet arm called SUNeVision, with a focus on venture capital investment in IT, healthcare and biotechnology and other technology related fields. (Sum, 2002)

*'The business sector in particular has responded positively and swiftly to this new course of development for Hong Kong.…We are pleased by this noticeable gathering of interest and action constituting a momentum for change within a short while.'* (Central Government Offices, 1999, p.2)

Table 5.7 Overview of the state of alignment conditions of the Hong Kong technology cluster at the end of this growth stage

| **Overview of state of alignment of Hong Kong's technology cluster at the end of its growth phase** |
|---|
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• The Chief Executive formally announced the technology development policy in his Policy Address, giving the technology cluster greater legitimacy.<br>• Initially, the major actors did not have the consensus for technology development and they did not perceive innovation and technology as highly important. However, after the repeated emphasis from the Government, the technology cluster began to receive support from its major target constituents.<br>• A cluster community began to emerge after the active persuasion of the Government. At the end of this stage, different actors, including local and overseas technology companies, property developers, financial institutions and universities were involved in the constituency building process.<br>• A mapping exercise was commissioned by the Government, which helped define the vision and the objectives of the technology cluster. Strategies were drawn and policy programmes launched at the end of this stage.<br>• The target problems were translated into the strategies of the technology cluster, namely to enhance innovative capabilities of firms, stimulate technological development and encourage commercialisation and application of technology in Hong Kong. However, no specific targets were identified.<br>• Publicly funded cluster support programmes and initiatives were rolled out (e.g., ITF, ARF, Cyberport, Science Park, GEM) and momentum began to build up. The private sector responded warmly to the Government's vision.<br>• The Government tried to mobilise public support for the technology cluster by drawing attention to the 'crisis' brought by the Asian Financial Crisis, but the Government did not have any plan to solve the immediate economic problems caused by the crisis. (see Governance Dimension 1)<br>• Problems begun to emerge since some property developers were excluded from the Cyberport project. They denounced the Government's decision making process and damaged the Government's credibility. (see Interacting Technologies/Constituencies 4)<br>• At the end of this stage, various companies had jumped into the 'hi-tech cluster' bandwagon by setting up technology businesses. However, many of them were opportunistic investors without a solid business foundation. This opportunistic investment would cause problems for |

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| the later development of the cluster constituency. |
| **(II) Nature and Maturity of the Technology**<br>• The content of this dimension remained very much the same as with the previous phase. That is, the focus of the effort was to build up a knowledge intensive technology cluster by upgrading Hong Kong technology companies' capabilities from mature, lower value-added activities, products and services, to the capability to research, design, develop, produce and sell more sophisticated high value added products. Although the Government highlighted the importance of ICT, no specific technology focus had been set, due to the Government's avoidance of 'winner picking' approach. |
| **Alignment (1) Governance**<br>• The Asian Financial Crisis had changed attitudes in Hong Kong and opened opportunities for a major constituency-building effort to create a technology cluster. However the government did not offer a clear plan to tackle the immediate economic problems created by the crisis. At the same time the technology cluster's vision 'to become an innovation centre of Asia' was vague.<br>• A self-defeating mentality was still prevalent in Hong Kong and people generally thought that Hong Kong did not have the capability to achieve that vision. The goal of 'enhancing innovative capabilities, technology development and commercialisation', set by the Government, was obscure and no specific and measurable target had been set.<br>• The Government has not yet set up any formal organisation to be in charge of the technology cluster. This inhibited the coordination among different government departments to implement a holistic plan for developing the technology cluster.<br>• The Government was under fire due to its mis-management of the Cyberport project in its early stage. The public mis-conceived that the Cyberport was a property development project instead of a technology infrastructure, due to PCCW's close connection with a Hong Kong property tycoon.<br>• The Government was too ambitious and wished to become an innovation centre in different sectors, such as ICT, biotechnology, fashion and financial services. The lack of focus of the technology cluster confused the public about the Government's direction and diluted the Governments' resources.<br>• The market governance began to play favourably as the Government's plan to develop a technology cluster resonated with some industrial leaders. They demonstrated their support to the Government by signing the tenancy agreement to become anchor tenants of the Science Park. Many private companies also announced their technology proposals, a momentum for technology development had gradually built up at the end of this stage. At the same time, the market also attracted opportunistic investment that eventually weakened the constituency-building efforts. |
| **Alignment (2) Nature of Target Problem**<br>• Although a number of initiatives have been put in place, the early state of these initiatives |

means that the nature of the target problem of the technology cluster remained as outlined in Table 5.3, including:

- To upgrade its traditional, low value added, volume manufacturing to knowledge based innovative, high value added, design and manufacturing
- To transform the economic structure of Hong Kong, to diversify the economy to include high technology industry, to reduce the dependency on the financial and service sector
- To transform the structure and governance of the industrial sector, to increase private sector R&D investment, encourage industry-university linkages, foster an entrepreneurial culture, etc.
- To tackle the problems highlighted in the 1998 Commission Report, such as shortage of scientist and researchers, to exploit the technology resources of China and to foster a general technology culture in Hong Kong.

• These broad target problems faced substantial challenges since Hong Kong was still troubled with the economic downturn and rising unemployment, and people doubted whether the Government's technology vision could help ease the economic problems. In addition, opportunistic investment helped reinforce this problem.

**Alignment (3) Target Constituents' Perceptions and Pursuits**

• At the beginning of this stage, the Government came across many difficulties in transforming target constituents into proper constituent of the technology cluster. First, the technology vision was mis-aligned with the perception of the service sector who wished the Government to uphold the service sector; second, the Government's high profile support to the technology industry violated the often applauded 'non-intervention' policy of Hong Kong Government. However, at the end of this stage, it seemed that the Chief Executive has successfully convinced these people of the importance of innovation and technology for Hong Kong and aligned them with the constituency building process, largely due to his keen support for the technology vision.

• At the end of this stage, the Government began to engage other target constituents, such as local and overseas technology companies, local universities, financial institutions, as well as technology organisations in China. The Government aimed to attract their interest to the technology cluster and helped them to become active constituents through persuasion and incentives.

**Alignment (4) Interacting Technologies/Constituencies**

• Hong Kong's technology cluster was facing fierce competition from similar efforts in neighbouring countries, such as Taiwan, Singapore, Malaysia and China. These countries also had science parks and were seeking similar foreign investors. At this stage, Hong Kong had yet to establish its unique position from which to attract these foreign investors. Hong Kong also lacked a competitive edge compared with neighbouring countries, due to its high structural costs and the refusal of Government to offer incentives.

• Another technology cluster, such as Chinese Medicine began to emerge. A few months after the announcement of the Cyberport Project, the Government decided to launch the Herbal Port project. The two projects inevitably competed for the same resources from the Government.

- Inside the technology cluster, as mentioned in Table 5.3, the range of technologies was very wide and different technologies/constituencies might compete or collaborate with each other.
- The technology cluster of Hong Kong might also interact with technology clusters elsewhere, such as those in China.

### 5.2.3 Period 3—Development of the Hong Kong technology cluster (2000-2002)

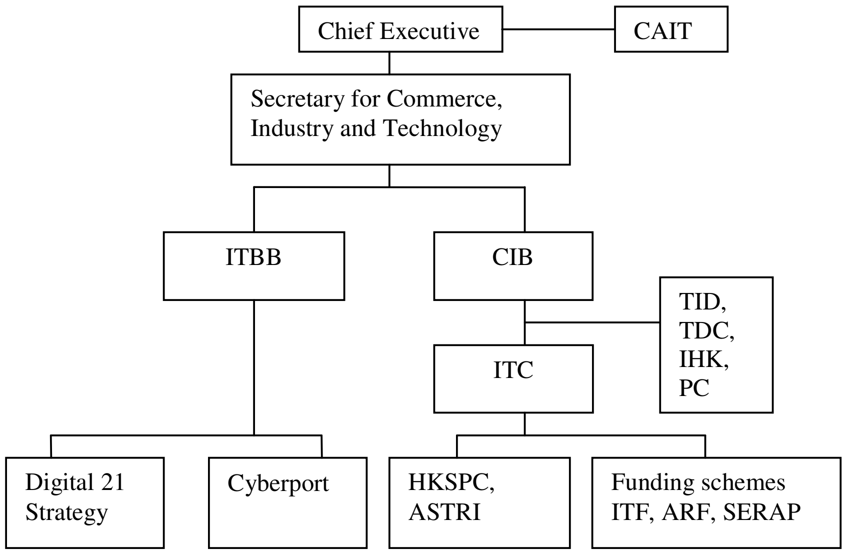
#### 1. Strengthening the governance of the technology cluster

#### a. Institutionalisation and provision of formal governance (2000)

In 2000, a number of institutional reforms were carried out. First of all, based on the recommendation of the Commission on Innovation and Technology, in April 2000, the Chief Executive appointed a **Council of Advisors on Innovation and Technology (CAIT**) to advise him on matters relating to the technology development of Hong Kong. In July of the same year, the Government set up the **Innovation and Technology Commission (ITC)**, a high level Government body under the Commerce and Industry Bureau to oversee the innovation and technological policies of Hong Kong. In the same month, the Government set up **Invest Hong Kong (IHK)**, an organisation entrusted with spearheading Hong Kong's effort to attract inward investment.

Besides, to strengthen Hong Kong's R&D capability, the Government set up the **Applied Science and Technology Research Institute Company Limited (ASTRI)** in 2000. Moreover, in order to provide support for SMEs, the Chief Executive appointed a **Small and Medium Enterprises Committee (SMEC)** in 2000 to advise him on the measures for enhancing the competitiveness of SMEs. In 2001, a new statutory body called the **Hong Kong Science and Technology Park Corporation (HKSTPC)** was created by merging the Hong Kong Science Park, Hong Kong Industrial Estates Corporation and the Hong Kong Industrial Technology Centre Corporation into one organisation with the aim of streamlining their operations. The institutionalisation process not only helped provide a legal status for the organisations taking charge of the technology policies of Hong Kong, but also provided a mechanism for the public to evaluate their work. The figure below shows the new institutional framework for promoting the technology cluster in Hong Kong.

Figure 5.1 The Government's new institutional framework for promoting the technology cluster (based on Commission on Innovation and Technology, Central Government Offices, 1999, p.76)

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|---|---|
| CAIT | Council of Advisors on Innovation and Technology |
| ITBB | Information Technology and Broadcasting Bureau |
| CIB | Commerce and Industry Bureau |
| ITC | Innovation and Technology Commission |
| TID | Trade and Industry Department |
| TDC | Trade Development Council |
| IHK | Invest Hong Kong |
| PC | Productivity Council |
| ASTRI | Applied Science and Research Institute |
| HKSPC | Hong Kong Science Park Corporation |
| ITF | Innovation and Technology Fund |
| ARF | Applied Research Fund |
| SERAP | Small Enterprise Research Assistant Programme |

**b. Creating an innovation milieu and informal governance**

The Government proactively fostered a macro environment which was conducive to the development of the technology cluster through the implementation of the **Digital 21 Strategy** in 1998. A wide range of programmes have been included in the strategy, such as liberalising of telecommunications and broadcasting regimes, developing a world-class telecommunications infrastructure, putting in place a secure framework for conducting e-business. In order to foster a vibrant IT market, the Government progressively put its services on-line and outsourced two-thirds of its new IT projects. In 2000-2001, up to HK$750 million of Government's IT work was outsourced. (Information Technology and Broadcasting Bureau, 2001) Besides, a campaign called '*IT Hong Kong*' was launched to help enhance public access to free computer facilities, and offer some training courses to promote the wider use of IT in the community.

To sustain the momentum and enhance the public's awareness on technologies, the Government took part in various local and overseas exhibitions, seminars and conferences in relation to technology development.[42] Besides, ITC produced publicity materials for broadcasting on television and radio to promote the Government's funding and supporting schemes on innovation and technology. All these publicity and promotional events helped foster an innovation and technology milieu in Hong Kong.

Next to the Government promotion, the trade associations of Hong Kong also took on an important role to foster a market governance favourable to the technology cluster. For example, the trade associations collaborated with the Government to co-organise seminars or conferences to promote the use of IT in business. Each year, the Chinese Manufacturers Association of Hong Kong and the Federation of Hong Kong Industries collaborated with the Government to organise the Hong Kong Awards for Industry. Started in 1997, a new award, namely, the technology achievement award, was added to encourage industrial innovation.[43] These trade associations helped bring the industry together and mobilise it to support the Government's technology cluster development policies.

**2. Further growth of the technology cluster (2001)**

**a. Increasing number of initiatives**

Following the establishment of the formal organisations, the Government fully launched all the major initiatives to strengthen the technology infrastructure and promote innovation and technology development in Hong Kong. It also sought to strengthen relations with mainland China. Thus, the Government also embarked on a discussion with the technology-related

[42] For instance, the ITC organised the 'Innovation Expo', a large scale biennial technology event in 2001, which included a series of public forums and seminars enabling industry and academics to discuss how to enhance their cooperation in order to generate wealth in the knowledge economy, and to consider issues in the technology development of Hong Kong industries. (Ta Kung Pao, 23 November, 2001a) The Expo attracted more than 13,000 visitors.

[43] These trade associations also helped raise the profile of the event by inviting senior government officials, such as the Financial Secretary, to attend the prize giving ceremony and publishing special supplements and full page advertisements in local newspapers.

authorities of China about setting up formal liaison mechanisms. In 2000, the Government also allocated a funding of HK$356 million to finance **joint research projects** conducted by Hong Kong and mainland institutions. Besides, in 2001, the Government announced the setting up of four **SME funding schemes** aimed at helping SMEs to improve overall competitiveness, and purchase business equipment and appliances. The amount of funding was HK$ 1.3 billion. (Information Services Department, 2001)

In May 2001, the Government set up the **Hong Kong Jockey Club Institute of Chinese Medicine Limited (HKJCICM),** which operates as a subsidiary of ASTRI, to take forward the policy vision to develop Hong Kong into a world centre for health food and pharmaceuticals, based on Chinese medicine.[44] In 2001, the Government also announced the setting up of the **Hong Kong Design Centre (HKDC)**[45], an initiative proposed by four leading design professional bodies in Hong Kong with an aim to raise design standards and foster design-related education.

In addition, the HKSTPC announced the launch of an improved **incubation programme** in late 2001. Differing from the old programme, which only gave rental discount to the incubatees, a number of value-added business services were added to the new incubation programme. After joining the incubation programme, incubating companies would also be able to have access to technical expertise from universities and industry in Hong Kong and the Mainland, and benefit from the networking opportunities. The major initiatives for supporting the development of the Hong Kong technology cluster by 2001 was summarised in Table 5.8.

Table 5.8 Summary of major Hong Kong Government's initiatives for supporting the development of Hong Kong's technology cluster in 2001 (source: Innovation and Technology Commission, 2001)

| ***Funding:*** | |
|---|---|
| **Innovation and Technology Fund (ITF):** | The HK$ 5 billion ITF was set up in 1999 and has four programmes, namely<br>• **Innovation and Technology Support Programme (ITSP)** |

[44] The institute was funded by a donation of HK$500 million from the Hong Kong Jockey Club Charities Trust.

[45] Again, the Hong Kong Jockey Club Charities Trust donated HK$6 million to establish the Design Centre, matching the Government grant of HK$10 million for its initial operating costs.

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|---|---|
| | • **University-Industry Collaboration Programme (UICP)**<br>• **General Support Scheme (GSP)**<br>• **Small Entrepreneur Research Assistance Programme (SERAP)**<br>(See Appendix 6 Table A6.13 for details) |
| **Applied Research Fund (ARF):** | The HK$ 750 million ARF was set up in 1998. Its aim is to promote technological entrepreneurship in Hong Kong. |
| **Funding for Mainland-HK joint research project (M-HKJRF)** | Set up in 2000, a fund of HK$356 million to support research projects jointly conducted by Hong Kong and Mainland institutions. |
| **Funding for SMEs (SMEF)** | Four funding schemes were set up in 2002 to support SMEs in securing loans, enhancing human resources, expanding markets and improving overall competitiveness. They are:<br>• **SME Business Installations and Equipment Loan Guarantee Scheme**<br>• **SME Export Marketing Fund**<br>• **SME Development Fund**<br>• **SME Training Fund**<br>The total commitment by the Government amounted to HK$7.5 billion. |
| **Growth Enterprise Market (GEM):** | GEM was set up by the Hong Kong Stock Exchange in 1999. It is a Second Board in Hong Kong providing an alternative market for emerging growth companies. |
| ***Infrastructures:*** | |
| **The Hong Kong Science and Technology Park Corporation (HKSTPC):** | Set up in 2001, HKSTPC is the statutory body that in Hong Kong provides one-stop services and infrastructures for technology companies. It was formed by merging the Industrial Estates, Technology Centre and Science Park. Apart from being in charge of the day-to-day operation of the **Hong Kong Science Park (HKSP)** in Pak Shek Kok, HKSP hosts four technology clusters for the electronics, IT& telecommunications, precision engineering and biotechnology sectors. Two supporting centres, namely the **IC Development Centre (IC)** and **Photonic Centre (PC)** have been opened in 2003 to provide a wide range of technical assistance to companies engaging in IC design and precision engineering. Besides, a number of business supporting services are available for |

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|---|---|
| | Science Park's tenants, including:<br>**-Incubation programme (Incu-Tech)**<br>Started and operated by the HKSTP in 2002, Incu-Tech provides incubation aid packages to technology start-ups of up to HK$206,000 for three years, including:<br>-**Technical & Management Assistance Fund**<br>-**Training Fund**<br>-**Marketing Assistance Fund**<br>-**Operation Reimbursement Fund**<br>**-Technical Assistance Programme (TAP)**<br>Introduced in 2002, TAP enables Science Park tenants to gain access to university resources in Hong Kong and the Mainland. A **Technical Assistance Fund** is available to cover the costs of technical assistance, a Teaching Company Scheme, student projects and training programme by the Institution of Engineers. |
| **Cyberport (CP)** | Located in Telegraph Bay, CP was built in 1999 with the aim to develop a strategic cluster of ICT companies and a critical mass of professional talents in Hong Kong. CP was completed in 2004, and provides 120,000 sq meter of office space to accommodate over 100 companies. In 2003, the Government sponsored the setting up of a **wireless development centre (WDC)** and a **digital media centre (DMC)** at CP. |
| **Applied Science and Technology Research Institute (ASTRI):** | ASTRI is a government funded research institute set up in 2000. It performs mid-stream research with the aim of transferring technologies to industry for commercialisation purposes. |
| **Hong Kong Club Jockey Institute of Chinese Medicine (HKCJICM)** | Set up in 2001 with a donation of HK$500 million from Hong Kong Jockey Club to conduct research in relation to Chinese medicine. It aims at developing Hong Kong into a centre of health food and pharmaceutics based on Chinese medicine |
| **Hong Kong Design Centre (HKDC)** | Set up in 2001, HKDC is a multi-disciplinary design centre aiming to raise the design standard of Hong Kong and promote design related education. |
| ***Human resources:*** | |
| **Admission of Talents Scheme (ATS)** | Introduced in 1999, ATS allows companies to employ talents from all over the world. There is no restriction on the sectors. |

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|---|---|
| **Admission of Mainland Professionals Scheme (AMPS)** | Introduced in 2001, AMPS allows companies to employ talents from Mainland China, It is limited to the IT and financial sectors only. Applicants should be employed by a private company and must be qualified professionally. |

**b. Defining the technology focus and formation of ICT cluster (2001)**

At the beginning, the cluster building initiatives were available for companies from all sectors. In late 2000, however, the Government began to identify the key technology focuses for development. In particular, ICT was chosen as the main target for the Hong Kong technology cluster. For instance, a theme-based programme was developed for the ITF, focussing on the opportunities brought by information technology and biotechnology. Projects on specific themes were encouraged to apply to the ITF. The press release from the ITC spelled out the reason for this change:

> *'This has enabled a more focused approach to encourage applicants to come up with projects on themes that are considered important to the future development of Hong Kong industries.'* (Information Services Department, 3 January, 2001a)

Besides, the Government allocated HK$3 billion to fund research projects conducted by ASTRI in a few selected ICT areas as its R&D targets, including optical, wireless, internet contents and applications, and semiconductor design. (Information Services Department, 22 November, 2001) In 2000, the Government also founded four 'clusters'[46] in the Hong Kong Science Park (HKSP) based on four technology themes. They are **electronics, information technology, biotechnology and precision engineering**. The tenant of the Hong Kong Science Park must be engaged in one of these technology intensive businesses. As described in the Hong Kong Science Park's brochure:

> *'The clustering effect will help attract worldwide recognition and more tenants to HKSP, the Asian hub of innovation and technological growth.'* (Hong Kong Science Park, 2000)

The renewed incubation programmes organised by HKSTPC also introduced new themes. The new programme was targeted to start-ups engaging in multimedia and internet, microelectronic and components, software and computer systems, and telecommunications. (Hong Kong Economic Times, 21 July 2001) At this stage, the position of the technology

[46] From this stage, the Government specifically began to use the term 'cluster' to refer to its targeted supporting industrial sectors.

cluster of Hong Kong became clearer and its related initiatives developed a consistent theme to support the development of ICT.

### 3. New crisis of the technology cluster (2001 onwards)

#### a. The economic setback and global ICT downturn

When the technology cluster of Hong Kong seemed to progress well, an incident took place on the other side of the globe which seriously affected its later development—the 9/11 terrorist attack, and the consequent downturn in the US and global economies. With a significant worsening in the global economic environment, Hong Kong's domestic exports dropped by 11% in real terms in 2001, which was the largest annual decline since 1962, when statistics were first recorded. The Hong Kong economy underwent a distinct slow down throughout 2001, with its GDP growth decelerated sharply from 10.5% in 2000 to a mere 0.1% in 2001. (Financial Service Bureau, 2002, p.7-9)

In 2001, the global electronic industries were in a down-cycle and poor business performance was shown by ICT giants such as Nokia, HP, and Sun Microsystems. Electronic components, which accounted for the largest share by value of Hong Kong's total exports of goods at 14%, fell by 8% in the second half of 2001. Telecommunications and sound recording and reproducing equipment, which accounted for 10% of Hong Kong's export value, also dropped 9% in value terms in the second half of the year. (Financial Services Bureau, 2002, p.59)

#### b. Down phase of the Hong Kong technology cluster (2001-2002)

In the meantime, the construction of the Cyberport and the Science Park had been partially completed. Around 2001 to 2002, these two flagship projects of the technology cluster began to recruit tenants. However, the conditions for renting out of these properties were unsatisfactory. One of the Government's strategies was to attract Hong Kong diasporas in Silicon Valley to come back to set up their R&D centres, due to the poor performance of technology stocks and the 9/11 incident, many US companies backed away from further investment. As a result, in 2002, the Cyberport had only three technology companies signed up for the tenancy contract which was in marked contrast to the situation two years earlier, when 155 firms expressed their interest in the project. (Hong Kong iMail, 6 April, 2002) The Hong Kong Science Park was also struggling to find tenants for its first phase. (South China Morning Post, 4 April, 2002) It only rented out 30% of its office space to 10 tenants.

The unsatisfactory rent conditions provoked much criticism from the public, who had already disapproved of the two projects from the very beginning. Their primary argument was that Hong Kong had no need for these two projects. On 29 May 2002, a local newspaper published an article with the headline '*Cyberport and Science Park may be redundant'*, claiming that the advanced communication infrastructure in Hong Kong made it unnecessary to physically cluster IT specialists. (South China Morning Post, 29 May, 2002) Some people also criticised the Government's mis-management in creating two similar infrastructure projects, which were actually competing with each other for tenants and resources. Moreover, many people disagreed with the Government's use of public money to subsidise the rent in Cyberport and the Science Park. The following scornful remarks, from a local newspaper, reflected the media's disapproval of the of the Governments approach.

> *'Science Park's biggest draw is cheap government-subsidised rents.'* (South China Morning Post, 19 April, 2001)

> *'What it comes down to is that Science Park tenants will be given the sweet of joy of steeply discounted rents at the ultimate expense of the taxpayer…'*(South China Morning Post, 3 May, 2001)

Hong Kong's Science Park and Cyberport also faced fierce competition from similar infrastructural projects in neighbouring countries, which raised concerns about Hong Kong's competitiveness in attracting overseas technology companies. Unlike many neighbouring countries, the Hong Kong Government did not provide financial incentives to attract investment. Although the Government contended that the low corporate taxes and good business infrastructure of Hong Kong, would make Hong Kong the better attraction, it was obvious that the cheap rental price of these two infrastructural projects were not enough to draw more overseas technology companies to come to Hong Kong.

The lack of progress of other major initiatives also has drawn much criticism. For example, on 5 January 2002, a local newspaper revealed that since the establishment of ITF in 1999, only HK$0.526 billion out of the total HK$ 5 billion had been approved for the funding of 216 projects, despite the ITC having received a total number of 1,136 applications. (Apple Daily, 5 January 2002) Moreover, the Matching Grant scheme for encouraging industry-university linkages did not achieve the expected results. In a public forum, organised by the University Science and Technology in May of 2002, the speakers from academia openly condemned the Government's poor execution of the funding scheme.[47] In their concluding remarks, they urged that *'it [the Government] should empower and motivate universities and technology entrepreneurs to pursue scientific research, technology development and innovation commercialisation instead of stifling their interest and creativity with bureaucracy and micro-management.*' (HKUST, May-July, 2002)

In view of the above difficulties, more and more people began to believe that the vision 'to become a centre of innovation and technology development' was ill-suited to Hong Kong. They felt that the technology development programmes were a waste of money and time and that Hong Kong would struggle to achieve its aim.

### 4. A new cluster champion and emergence of new opportunities (mid-2002)

While the technology cluster of Hong Kong was facing difficulties, two significant events took place which gave the cluster another chance to grow. First, on 11 December 2001, China formally became the 143rd member of World Trade Organisation (WTO). Under the WTO Agreement, China was expected to open its market for foreign trade and investment and this brought ample enriched business opportunities for Hong Kong. Second, in February 2002, the Hong Kong Science and Technology Park Corporation announced the appointment of Mr. CD Tam as the new chief executive officer of HKSTP.[48] He was regarded as a person who had the experience, knowledge and credibility to lead the Hong Kong technology cluster[49]. After he took the office in April 2002, a number of re-alignment efforts were carried out.

#### a. A new focus for the Science Park—IC design

The first thing he did was to announce a sharpened focus for the Science Park—IC design. Based on his experience working in Motorola, he believed that Hong Kong had a competitive advantage in microelectronic design[50] and envisioned Hong Kong to become the '***IC design***

[47] For example, they found it difficult to support the scheme since the Government refused to provide universities with overhead funding for the execution of research programmes. (HKUST, May-July, 2002)

[48] Prior to joining the HKSTP, Mr. Tam was the Executive Vice President of Motorola Inc., the highest global position ever attained by a Hong Kong citizen in Motorola. He served 33 years in the company and had been widely involved in many aspects of industrial and educational technological development activities. (Hong Kong Economic Times, 21 February, 2002)

[49] Many local newspapers applauded his appointment, for example, a newspaper used the headline '*Top Motorola Executive seen as man to turn Science Park into success*' (South China Morning Post, 22 February, 2002)

[50] Motorola's IC design centre, namely the 'Silicon Harbour Centre' had been set up in Hong Kong in the 1980s. Over the years, the centre has developed many outstanding IC products, such as 'Dragon Kat', a 8-bit highly integrated microcontroller (MCU) widely used in electronic dictionary products

***centre of Asia'***. (Ta Kung Pao, 10 June, 2002) This new focus was also in accordance with the booming micro-electronics market in China which would provide huge business opportunities for Hong Kong[51]. Given the fact that there were only about 20 companies in Hong Kong engaging in IC design, HKSTP launched a series of new programmes to attract more overseas IC design companies to open R&D centres in Hong Kong, as well as to support the development of local ones.

**b. Create edges for the Science Park**

In order to strengthen the infrastructure of Hong Kong for supporting the development of the IC design industry, the HKSTPC announced a number of new plans, including, in collaboration with the ASTRI, the setting up of an integrated circuit design support centre, namely the **IC Development Centre (IC)** and a **Photonic Centre (PC)** at the Science Park. The former would provide a number of value added services to IC design companies like IC Library, specialised IC CAD tools and wafer shuttler (Hong Kong Commercial Daily, 20 April, 2002), the latter would host a photonic development support centre, a product analysis laboratory and R&D facilities for companies engaging in precision engineering, nanotechnology and optoelectronics.

In addition to the above, the HKSTPC decided to provide more value added business services to its Science Park tenants, so as to enhance the attractiveness of the Hong Kong Science Park to overseas and local technology companies. A **Technical Assistance Programme** was launched in April 2002 which aimed at enabling Science Park tenants to gain access to university resources in Hong Kong and the Mainland. A fund had been set up to cover technical assistance, teaching company scheme, student projects and training programmes for the Science Park tenants. (Hong Kong Economic Times, 20 April, 2002) Certain subsidies would also be given to tenants to recruit fresh graduates from Hong Kong and China.

**c. Step up promotion effort**

The accession of China to the WTO encouraged many US and European companies to expand their businesses to China, whereas Hong Kong was regarded as a speedy, but low-risk foothold, for them to enter into China. In view of this, the HKSTP decided to step up its

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and 'Dragon Ball', a 32-bit embedded microprocessor which has been bought by a Silicon Valley company Palm and which is still being extensively used in Palm Pilot, its world famous personal data assistant (PDA) products.

[51] It was predicted that the turnover of micro-electronic products in China would increase from US$12 billion, in 2000, to US$100 billion in ten years. (Ming Pao Daily News, 13 January, 2002)

promotion effort and use the unique position of Hong Kong as the 'gateway to China' to attract more overseas technology companies to come to Hong Kong. The HKSTPC organised a series of large scale road shows to a number of high-tech countries in Europe and the US to promote the Hong Kong Science Park. In 2002, the HKSTPC roadshow team which comprised 40 members from the government departments and industrial leaders, visited Finland and Sweden[52] and Silicon Valley in the US[53], where they persuaded IC design companies to open IC design centres in Hong Kong to capitalise on the growing ICT market in China. They promised that the Hong Kong Science Park could help its tenants to make connection with companies in China.

**d. Leverage on external resources—economic integration with PRD & attract mainland talents**

The Hong Kong Government's efforts to promote high-tech industrial development has been hampered by two problems—high production costs and the shortage of local talents. To deal with these two problems, more and more policy-makers and scholars proposed to increase leverage on the external resources from China. (HKUST, May-July, 2002) They proposed that people should see Hong Kong and the Pearl River Delta (PRD) as one economic community. In PRD, inexpensive land and labour were available, which could become a high tech industrial zone like the Bay area in San Francisco in the US. MNCs might have their research and development, marketing, sales financial and administrative arms in Hong Kong and their production lines in the PRD of China. A strategy for Hong Kong to become the 'Dragon Head' of South China has been actively pursued with the aim of enhancing synergy for mutual benefits in future.

Despite Hong Kong's return to Chinese sovereignty under the premise of 'one country' in 1997, Hong Kong and China have operated under 'two systems', and there were restrictions over border control which prohibited the freedom of movement for people, goods and capital between the two places. Therefore, the Hong Kong Government decided to create more flexibility to the **Mainland Professional Admission Scheme** by relaxing its restrictions on all sectors and allow applicants to bring their families with them.[54] The Government also

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[52] The Science Park road show team met with the senior government officials there, ICT giants like Ericsson, Nokia, Sun Microsystems and other 30-40 companies engaging in information technology, electronics and biotechnology. Many of them expressed interest in the Hong Kong Science Park as they wanted to use Hong Kong as the stepping stone into China. (Ta Kung Pao, 2 May 2002)

[53] In the US's Silicon Valley, the road show team met with 20 technology companies and held a symposium, at which over 180 professionals attended. (Ta Kung Pao, 8 July, 2002)

[54] The introduction of Admission schemes for Mainland Professionals did not achieve satisfactory results. Since its inception in 2001, the scheme has recorded only 268 successful applications by the

proposed to provide incentives to tertiary institutions to attract academics and students from the Mainland and overseas, so as to bring more talents to Hong Kong.

**5. Opening of the Science Park and short-term success of the technology cluster (2002)**

After five years of consistent efforts by the Government, the technology cluster of Hong Kong began to achieve some results. The Government's initiatives to promote technological entrepreneurship attained better results. The incubation programme has increased its uptake of incubatees to 100 annually with the majority of them engaging in the software industry. The physical infrastructure to support innovation and technology was also progressing well. In June 2002, the electronic giant Philips signed on to take up nearly a whole building, for research and development, at the Hong Kong Science Park (South China Morning Post, 28 June, 2002), thus bringing the occupancy rate in its first phase to 70%. Another IT giant, Microsoft also signed a tenancy contract with Cyberport, bringing up the occupancy rate to 80%. (Information Technology Weekly, 3 July, 2002) Besides, the Hong Kong Design Centre also opened in September 2002 to provide a wide range of service to help Hong Kong manufacturers to upgrade from the OEM to the ODM mode of production.

Last but not least, the Chief Executive reaffirmed his commitment and dedication to support the development of the technology cluster in order to realise Hong Kong's vision of becoming 'an innovation centre of South China and Asia'. At the Opening Ceremony of the Hong Kong Science Park, he proclaimed:

> *'I can assure you that in my second term as Chief Executive I will continue to support steadfastly innovation and technology as a main driving force for a better and more prosperous Hong Kong. Let there be no misunderstanding about my commitments.'* (Information Services Department, 27 June, 2002b)

**6. Unresolved economic problems in 2002**

While the advancement of the technology cluster began to generate optimism about Hong Kong realising its vision, there were some unresolved economic problems. In 2002, the nominal rate of economic growth fell by 0.6% for the whole year. (Information Services Department, 2003b) Pay reductions and layoffs were prevalent, the unemployment rate reached 7%, which was the highest on record since the 1980s. Also, the Government faced

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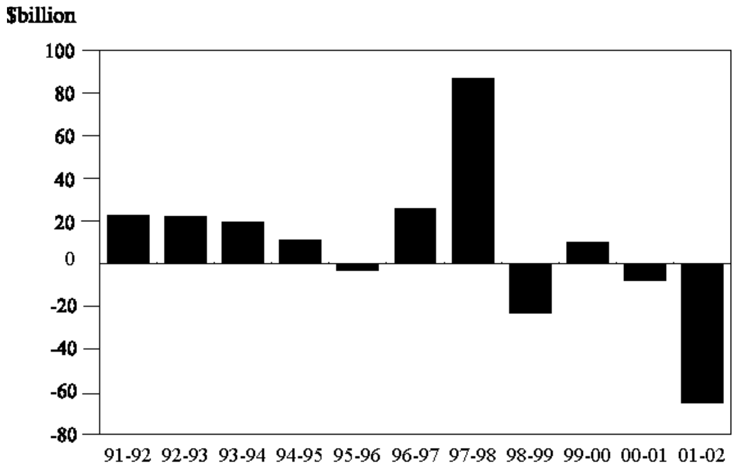
end of 2002. (Information Services Department, 2003a, p.25) The small number of successful admissions was caused by the restrictiveness of the scheme, in that it was confined to the information technology and financial services sectors only and successful applicants were not allowed to bring their spouse and children with them.

fiscal deficits for three consecutive years from 1998. In the financial year 2001-02, the Government deficit reached 5.2% of the GDP[55], amounting to HK$65.6 billion.[56] (Information Services Department, 2002) Figure 5.2 shows the consolidated deficits of the Hong Kong Government in the five years since 1997. To restore fiscal balance, the Government decided to reduce government expenditure to 20% of the GDP and to cut the payment of civil servants by 4.75%. (Information Services Department, 2002)

Figure 5.2 Consolidated deficits in past five years from 1997 to 2002. (source: Information Services Department, Budget Speech 2002-03, 2002, p.20)




Despite the Government attempted to solve the economic problems by introducing some short-term relief programmes[57], all these seemed unable to ease Hong Kong's economic problems whilst the public's discontent with the Government was mounting. For instance, street demonstrations of different scales were frequent, including one organised by civil servants in July 2002. The inability of the Government to solve the economic problems eroded public confidence in the Government. Table 5.9 shows the state of alignment of Hong Kong's technology cluster at the end of this growth phase.

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[55] A government deficit of 5.2% of GDP is quite a high rate according to the international standard. The European Union (EU) requires its member states to contain their fiscal deficit within 3% of GDP. In the US, the total amount of government deficit should not exceed 3% of its GDP.

[56] The Financial Secretary gave reasons for the huge government deficits at his 2002 Budget Speech. He pinpointed that on the revenue side consolidation in the property market has resulted in a structural diminution in revenue from land premiums, profits tax from the banking and property sectors, and stamp duty on property transactions. On the expenditure front, the price rigidity in government expenditure, which was particularly severe in times of deflation, coupled with the ageing population, which caused an increase of demand for social security payments, had led to an accumulated government deficit of HK$65.6 billion in 2002-03. (Information Services Department, 2002)

[57] The Government's short-term relief measures including: 1) to grant a one-off concession to all rate payers in 2002 and raise the tax deduction for home loan interest 2) to create over 30,000 job opportunities through enhancing social services 3) to speed up public works projects, earmarking about HK$29 billion for infrastructure works over the next five years. (Information Services Department, 2001) However, all these efforts seemed unable to turn around the economy.

Table 5.9 Overview of alignment conditions of the Hong Kong technology cluster at the end of its development phase

| **State of alignment of the Hong Kong technology cluster at the end of its development phase** |
|---|
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• At the beginning of this stage, the Government began to strengthen the institutional constituents of the technology cluster by 1) setting up new formal organisations, 2) actively engaging the industry, universities and the wider community to take part 3) giving commitment and resources to support the growth of the technology cluster<br>• Informal support was given by many trade associations, which encouraged their member companies to support the Government's technology programmes. This, coupled with the favourable innovative milieu developed by the Government's Digital 21 strategy helped the technology cluster gather momentum. Most of the technology supporting programmes were formally rolled out and to sustain the momentum, the Government decided to input additional resources to launch more supporting programmes, as well as levering resources from China. As a result, the technology cluster experienced a short-term healthy growth.<br>• The 9/11 Incident and global ICT downturn caused many target constituents, who had shown interest in joining either the Science Park or Cyberport to back away from the technology cluster, leading to a downward phase. The 9/11 Incident changed dramatically the 'market governance' (see below Alignment 1 - Governance) and revealed problems in the cluster strategy, and limitations in the government's ability to respond. In particular, the problems for the technology strategy re-emerged with the lack of progress of the technology cluster, which caused public criticism citing mis-management of the cluster by the Government. Indeed, the impact of the technology supporting initiatives so far had been limited due to their weak implementation and weaknesses both in the concept and in the administration of the government cluster strategy. These weaknesses were compounded by the crisis surrounding the cluster-building activity.<br>• Fortunately, a new cluster champion came on the scene and carried out a re-alignment effort that helped restore the public confidence in the technology cluster. In effect, the appointment of a technology expert from Motorola to be the technology cluster's constituency-builder led to an improvement in the cluster's governance and a more focused strategy and the launch of a number of re-alignment programmes that led to the improvement and renewed growth of the cluster.<br>• At the end of this stage, the Government had sharpened the goal of the technology cluster to focus on ICT, in particular IC design. The Government's new programmes were launched to give better support to the IC design industry |

| |
|---|
| **(II) Nature and Maturity of the Technology**<br>• The content of this dimension remained very much the same as with the previous phase. That is, the broad focus of the effort was still the build up of a knowledge intensive technology cluster. At this stage, however, the Government began to define more clearly the technology focus of the cluster with that of the ICT, and particularly IC design and photonics. This was definitely influenced by both the appointment of a new cluster champion, who was originally from Motorola, and the rising opportunities for microelectronics in the China market. It is interesting to note that this focus was very similar to the main focus of the Scottish technology cluster. |
| **Alignment (1) Governance**<br>• The change of market governance that resulted from the 9/11 crisis highlighted weaknesses in the cluster strategy and, consequently, the Government's lack of expertise to drive effectively the growth of the technology cluster. For instance, the refusal to give financial incentives and the blunt edge of the technology cluster are partly responsible for the failure to attract the expected number of overseas technology companies.<br>• Bureaucracy and Government red tape also made the funding schemes largely ineffective, causing discontent among the cluster stakeholders.<br>• Hong Kong was still troubled by serious economic problems and the people expected instant solutions to ease the economic problems. The Government's inability to re-generate the economy and the huge fiscal deficits led to a strained relationship with the public and eroded confidence in its leadership and its credibility. These fiscal deficits and the fact that the Government had to have a huge budget for social welfare meant an inevitable decrease in the resources available for the technology cluster.<br>• Although support came from target constituents, such as trade associations and the Chinese government, the community outside the cluster complained that the Government was using public money to subsidise foreign companies. These opposition forces obstructed the future growth of the technology cluster.<br>• China's accession to WTO offered opportunities to attract overseas technology companies to Hong Kong. |
| **Alignment (2) Nature of Target Problem**<br>• The nature of the target problem in this stage remained largely the same as outlined in Table 5.6.<br>• The Hong Kong government began to take steps to tackle some of the main obstacles in the way of the technology cluster. Thus, Hong Kong began to cooperate with China to solve its problems in relation to shortage of technology, capital and human resources. The geographically enlarged technology cluster would require new governance structure.<br>• Although the Government identified IC design as the new technology focus, given the sector was very small in Hong Kong (i.e. only about 20 companies), it required massive |

Government effort to attract foreign companies and to encourage local ones before an IC design cluster could be created. It also required the Government to put in place new infrastructures and cultivate/import the necessary talents for IC design.

- The growth of the technology cluster requires long term and sustained efforts to produce results, but this was affected by the public demand for instant results and the public discontent with the Government since Hong Kong's economic problems worsened due to the global economic downturn and the 9/11 Incident.

**Alignment (3) Target Constituents' Perceptions and Pursuits**

- In view of the low technological capability and small technology base of Hong Kong ICT industry, the Government had to target more overseas and local technology companies to become the constituents of the technology cluster. For the former, the intensified overseas promotion efforts from the Government, and the opportunities offered by China's accession to WTO, successfully attracted some overseas technology companies to come to Hong Kong. For the latter, the Government improved its incubation programme which helped improve the survival rate of the local technology companies.
- The proposed economic integration with southern China could help to solve Hong Kong's problem of high structural costs and bring economic benefit to both parties. Thus the Government began to discuss the cooperation plan with the new target constituents of the technology cluster, including the Chinese Government, research institutes and science parks in the Mainland. The Government also began to import technology talents from the Mainland to meet the local demand.

**Alignment (4) Interacting Technologies/Constituencies**

- Despite the denial from the Government, Cyberport and Science Park were similar technology infrastructural projects targetting similar ICT companies.
- The technology cluster of Hong Kong competed fiercely with other similar clusters in neighbouring countries for overseas investment. Hong Kong lagged behind due to the refusal of the Government to offer incentives. However, there were also chances for cooperation with other technology clusters, especially those in China. Overseas companies could set up R&D centres in Hong Kong due to its better IP protection and infrastructure, whilst China could become the production base for these companies, given its low cost land and labour.
- The converging trend of different ICT technologies implied that companies in the Hong Kong technology cluster, especially those engaging in electronics, information technologies, software, multimedia and photonics may have chance to cooperate with each other.

### 5.2.4 Period 4—Evolution of the Hong Kong technology cluster (2003-present)

#### 1. Urgency to solve economic problems and the outbreak of Severe Acute Respiratory Syndrome (SARS)

In 2003, the fiscal problem of the Government intensified. The deficit in 02/03 increased to 5.5% of the GDP and amounted to about HK$67.6 billion. (Information Services Department, 2003b)[58] Worse still, Hong Kong's economy was further hit by the spread of Severe Acute Respiratory Syndrome (SARS) in Asia. The World Health Organisation (WHO) issued a travel warning people to avoid going to SAR infected countries including Hong Kong. (Ming Pao Daily News, 16 March, 2003) As a result, the number of tourists to Hong Kong dropped substantially and seriously affected the service industries. The disease infected more than 1,700 people and 299 people died in Hong Kong. The public was furious at the Government's ineffectiveness in controlling the spread of the disease in the territory[59] and they requested the Government to 'do something' immediately to solve the current problems.

#### 2. A change of policy direction—strengthen the service industries

Since the long-term strategy of technology development failed to reinvigorate the economy, the Government decided to change the policy direction of Hong Kong. In 2003, the Chief Executive announced a new strategic direction for Hong Kong in his Policy Address as follows:

> '*Our direction and position are very clear. Backed by the Mainland and engaged globally, we are building Hong Kong as Asia's World City,* ***consolidating and developing our position as an international financial centre, a producer services centre, a hub for information services and logistics and a premier tourist destination.***' (Information Services Department, 2003, p.7)

In other words, the Government reverted to supporting the service industries of Hong Kong. Logistic, financial services, tourism and professional/producer services were identified as the 'pillars' of Hong Kong's economy. The Government's promotion of service industries could be said to have been encouraged, if not directly caused, by two issues. The first one was the

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[58] To resolve the problem, the Government decided to cut operating expenditure by HK$20 billion to HK$200 billion in four years, representing a reduction of about 9%. At the same time, the Government increased a number of taxes, including the salaries tax and profit tax, to generate more revenue. Under the Government's budget controlling plan, the establishment of the civil service had to be reduced by 10% to about 160,000 posts by 2006-7. (Information Services Department, 2003b) The funding for the eight universities in 2004/05 also suffered a cut of 10%, amounting to about HK$1.3 billion (Ming Pao Daily News, 14 March, 2003)

[59] The public conveyed their dissatisfaction to the Government through a large scale street demonstration—the **July 1 Rally** of 2003, in which about 500,000 Hong Kong people participated.

proposal by the Chief Executive's Commission on Strategic Development,[60] who compared Hong Kong to other cosmopolitan cities like New York and London and concluded that Hong Kong possessed many of their features such as being a world centre for international finance, tourism, trading and transportation. The Commission advocated that Hong Kong should further strengthen these roles in order to become '*Asia's World City'*. Second, the new direction was in-step with the latest policy change of China. In accordance with its WTO commitment, from January 2002, China began to open up the economy further for foreign participation, particularly in the service sectors.[61] It was expected that the opening up of the Mainland's service sectors would provide ample new business opportunities for Hong Kong. (Financial Services Bureau, 2002a, p.34-35)

In addition, in contrast to technological development, which generated limited benefits to the highly skilled workers and would take a very long time for the results to materialise, the service industry would instantly create jobs for the less skilled, and give immediate relief to the economic hardship. Therefore, shortly after the SARS crisis, the Hong Kong Government proactively negotiated with the Chinese Government a number of arrangements that would give a boost to the service industry of Hong Kong. These were:

1). To allow individual tourist to visit Hong Kong from the Mainland through the **Individual Visits Scheme**, which helped to revitalise the retail and catering sectors of Hong Kong.
2). To reach a new cooperative agreement with China, namely the **Closer Economic Partnership Arrangement (CEPA)**[62], which enabled Hong Kong manufacturers and service providers to gain early and preferential access to the Mainland markets.
3). To enable banks in Hong Kong to conduct **personal renminbi (RMB) businesses and provide clearing arrangements**, which helped strengthened Hong Kong's position as an international financial centre.
4). To improve border controls to facilitate the flow of people and goods between the two places and to speed up the construction of a number of logistic related infrastructures.

[60] In 1998, the Chief Executive appointed a Commission on Strategic Development to identify the long term development needs and goals of Hong Kong in the next 30 years. The commission interviewed over 180 stakeholders from Hong Kong and their findings were published in a report, namely *Bringing the Vision to Life—Hong Kong's Long Term Development Needs and Goals* in 2000. The Chief Executive had adopted the ideas presented in the report and articulated them in his Policy Address in 1998, 1999 and onwards.
[61] For instance, foreign companies were allowed to form joint venture with domestic enterprises to provide services in the Mainland in the telecommunications, land transport, automobile repair and maintenance, and travel and tourism industries.
[62] For example, the CEPA encourages Mainland banks to relocate their international treasury and foreign exchange trading centres to Hong Kong. It also allows 273 items of Hong Kong products to be imported into the Mainland tariff fee.

**3. Ease off of Government support and limited progress of the technology cluster (2003)**

At the same time, the easing of the Government's support to Hong Kong's technology development was evident. First, in the 2003 and 2004 Policy Address, the Chief Executive no longer mentioned the vision of being 'an innovative centre for south China and Asia'. Second, in the 2003 Policy Address, no new initiative was introduced to strengthen the development of the technology cluster. Though it did not mean that the Government dropped the strategy completely, the strategy for developing technology was subordinated to the strategies for enhancing the '**producer services**', in which the application of technologies, in particular ICT, was to improve supply chain management, brand name building, e-commerce and related activities.

During the turbulent year of 2003, the development of the technology cluster faced a number of setbacks. First, the public began to criticise the Government's technology supporting programmes claiming they were unable to produce the expected satisfactory results. For example, the league table conducted by the World Economic Forum showed that in 2002-03, the ranking of Hong Kong, in the global IT environment dropped five places from 13$^{th}$ to 18$^{th}$, compared with the previous year, which was lower than neighbouring countries like Singapore (3$^{rd}$), Taiwan (9$^{th}$) and South Korea (14$^{th}$). (Ming Pao Daily News, 23 February, 2003) Moreover, a news report on 11 February 2003 revealed that for the five year operation of the ITF, since its inception in 1999, only 118 projects were completed, of which 45% of the research results have been classified as '**unable to finish or impractical**'. It was estimated that about HK$130 million of public money had been wasted. Besides, the result for ARF was not satisfactory either. Among the 21 companies awarded with ARF, four of them went bankrupt and the Government lost about 33% of the total amount being invested, meaning a loss of about HK$110 million of public money. (Ming Pao Daily News, 11 February, 2003)

**4. A recovering economy and evaluation of the technology cluster (2004)**

In late 2003, due to the gradual improvement of the world economy, coupled with the economic revitalising measures implemented by the Hong Kong Government, the economy of Hong Kong showed signs of recovery. External trade grew strongly, with the exports of goods recording a double digit growth in real terms. The implementation of the 'Individual Visit Scheme' attracted more than 670,000 visitors from China, who contributed greatly to the recovery of the retail and catering businesses in Hong Kong.

Meanwhile, the Government decided to conduct a comprehensive evaluation of the effectiveness of the technology policies of Hong Kong five years after their inception. (The detailed evaluation of the Hong Kong technology cluster is given in section 5.3) Based on the results of the evaluation, in June 2004, the Innovation and Technology Commission published a consultation paper, namely the *New Strategy of Innovation and Technology Development,* in which a new strategy to improve the future technology programmes was proposed. Table 5.10 summarised the major elements of the new strategy.

Table 5.10 Summary of new strategies to further promote the development of Hong Kong technology cluster (source: Information Services Department, 20 February, 2004g)

| | |
|---|---|
| **Focus** | To identify key technology areas where HK has competitive advantages for optimal use of resources to create greater impact |
| **Market relevance** | To adopt a demand-led market driven approach, in driving the innovation and technology programmes, to ensure that HK's investments are relevant to industry and market needs |
| **Industrial participation** | To involve industry closely in defining the key focus areas and other stages of innovation and technology development |
| **Leverage on the Mainland** | To capitalise on the opportunities presented by the Mainland and Hong Kong Close Economic Partnership Arrangement (CEPA) and to utilize the production base in the Greater PRD as the platform for developing HK's applied research and development (R&D) and commercialisation of applied R&D deliverables |
| **Better coordination** | To strengthen coordination among various technology-related institutions and the industry for enhanced synergy and impact |

**5. Re-alignment process for the technology cluster in action**

**a. A focused approach—identifying new technology targets**

In the past, Government's technology supporting programmes, such as ITF used to support projects initiated by individual researchers and companies. However, it was not very conducive to building a significant focus or cluster. Since the Government's resources were relatively limited, to enhance the chance of success it was necessary to adopt a focused approach and concentrate on developing a few areas where Hong Kong was strong. In the consultation paper, the Government announced a number of targeted technology areas in which either Hong Kong had developed the R&D capability over the years, or has the potential to explore in the future. They were **integrated circuit design, photonics, wireless communications, digital media entertainment, applied nanotechnology, biomedicine and Chinese medicine.**

**b. Emphasis on market-led approach—Setting up of new R&D Centres**

Despite universities having developed R&D capabilities in many areas, they were not necessarily able to meet the needs of companies. The unsatisfactory results of ITF demonstrated that there was a gap between the university research and the market demand. In view of the above, the Government decided to improve the relevance of applied R&D to the needs of industry by setting up market-driven **R&D Centres (R&DC)**. Also, theme based research projects, undertaken at the research centres, would be conducted with different modes of cooperation, such as sponsorship, collaboration, contract research or forming consortia between universities and industry. It was expected this would help enhance coordination and networking among R&D institutions and industry. As stated in the ITC's consultation paper:

> *'The proposed R&D Centres would be responsible for developing core competencies in specific focus areas, acting as a focal points for conducting applied R&D and provide platforms for commercialisation of applied R&D deliverables.'* (Innovation and Technology Commission, 2004a, p.iv)

To find out from stakeholders about the technology areas which should be the focus of R&D Centres, the Government invited different industry members, trade associations and research institutions to provide feedback on the consultation paper. Finally, based on their feedback, the Government concluded that five R&D Centres would be set up for the following technology areas:

- ICT (consumer electronics, communication technologies, IC design and optoelectronics)
- Automotive parts and accessory systems
- Logistics and supply chain management enabling technologies
- Textiles and clothing
- Nano technology and advanced materials

**c. Prioritisation of funding schemes**

Under the new strategic framework, the Government also started to prioritise the distribution of government funds, so as to maximise their benefits to the relevant stakeholders. Accordingly, the ITF would adopt a new three-tiered funding model:

- **Tier one** would be for the R&D Centres.[63]
- **Tier two** would be for individual project under focused themes[64]
- **Tier three** would be for individual project which involved new technologies with good market potential, but which might not have immediate application.[65]

**d. Moving up the value chain through design and innovation**

In addition to the above, the Government launched a new initiative, namely the **Design Smart Initiative (DSI)** in June 2004 with the objective of promoting the wider use of design and innovation in industries. The Government earmarked HK$250 million for the Initiative, including the operation of four funding schemes to support design research, design/business collaboration, design professional continuing education, as well as fostering the culture of design. The Government also provided funding support to the development of a one-stop shop venue, namely the **InnoCentre (InnoC)** which aimed at creating a cluster of high value-added design activities among design professionals and companies.[66]

**e. Enhancing cooperation with China**

Over the years, Hong Kong companies had developed a strong manufacturing base extending beyond Hong Kong into the Pearl River Delta. The opportunity for upgrading the technology of the 60,000 Hong Kong related enterprises in the PRD was tremendous and such upgrading would help enhance their value adding capability and competitiveness. In May 2004, the Ministry of Science and Technology of China and the Commerce, Industry and Technology Bureau of Hong Kong signed an agreement to establish the **Mainland and Hong Kong Science and Technology Cooperation Committee (M-HKSTCC)**, which was mainly

[63] The ITF would be deployed to cover the cost of the initial operation of the R&D Centres and to sponsor individual projects undertaken by them.
[64] The focused technology themes include advanced manufacturing technologies, digital entertainment, display technologies and medical diagnostics and devices. Individual projects would be supported under the Innovation and Technology Support Programme (ITSP) of the ITF.
[65] It would be available for funding individual projects by universities and research institutes through the ITSP based on the ‘bottom up’ approach.
[66] Opened in November 2006, the InnoCentre serves as a design hub to support and accelerate the use of design for Hong Kong’s industries. It provides purpose-built office space, exhibition halls, training and meeting facilities, and design showrooms for design companies.

responsible for outlining the framework for technology cooperation between the Mainland and Hong Kong.

In September 2004, the Guangdong Provincial Department of Science and Technology and the Innovation and Technology Commission jointly launched the **Guangdong and Hong Kong Technology Cooperation Funding Scheme (G-HKTCFS)**. The purpose of the scheme is to encourage collaboration among universities, research institutions and technology enterprises in Hong Kong and Guangdong, in carrying out applied R&D projects that will facilitate industry upgrading and economic development in the Greater Pearl River Delta region. Under the scheme, Hong Kong and Guangdong provided funding support to R&D projects in six technology areas of common interest.[67] (Information Services Department, 2005)

### 6. Attract inward investors from China and departure of cluster builders (2005)

#### To attract more technology inward investors from China

While Hong Kong has long been regarded as the gateway to the Mainland, Mainland enterprises also began to see Hong Kong as an ideal platform for 'going global', since Hong Kong could help them raise capital and develop international trading networks. In August 2004, the Ministry of Commerce of China launched a new policy to encourage Mainland enterprises to invest in Hong Kong. In response to this new policy, Invest HK has put in place a series of measures to provide one-stop services for potential Mainland enterprises, including those engaging in high technology industries, that wish to set up operations in Hong Kong. As a result, the number of Mainland enterprises with regional headquarters in Hong Kong grew more substantially than in previous years.

#### Departure of two cluster builders

In March 2005, Chief Executive Chee Hwa Tung, the chief architect of the Hong Kong technology cluster resigned from his post due to 'a steady decline in his general health'.[68] (Information Service Department, 13 March 2005c) After his resignation, in May 2005,

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[67] The six technologies were RFID technologies, automotive parts and accessory systems, electronic and information technology, new materials and fine chemical processing, critical precision manufacturing equipment, and new energy and energy-saving related technologies.

[68] However, many people suspected Mr. Tung was asked to step down by the Central Government of China due to his unpopularity with the Hong Kong people.

another prominent leader, Mr. CD Tam, the CEO of HKSTPC also announced his retirement and he left on 31 May 2005 after leading the technology cluster for three years.

## 7. Latest development of the technology cluster (2006)

The new Chief Executive Mr. Donald Tsang took office shortly after the early retirement of Mr. Chee Hwa Tung. In his first Policy Address for 2005-06, he declared the new direction of Hong Kong:

> *'…**to consolidate our position as Asia's world city and our role as a key international financial, trading, transportation and information hub of China.** This strategy has delivered significant results and has allowed us to bring into full play our comparative advantages.'* (Information Services Department, 2005b)

As the above quotation indicates, his main policy direction was to continue to support Hong Kong's service industry. In his Policy Address nothing was mentioned about technology development. However, it did not mean that the technology cluster was shattered. In fact, it continued to operate but seldom caught the attention of the mass media. In January 2006, a new CEO was appointed to take over HKSTC after the retirement of Mr. C D Tam. Mr Carlos Genardini, the former vice-president and manager of Motorola's Asia Pacific Group became the new leader of the Hong Kong technology cluster.

### Consolidating the ICT cluster

In October 2006, the Government published the public consultation paper on **Digital 21 Strategy**, in which the strategy for developing the Hong Kong ICT cluster from 2007 to 2010 was outlined. At the beginning of this document, the Government reaffirmed the importance of technology and innovation to Hong Kong:

> *'Technology and innovation will continue to play a key role in **helping Hong Kong to compete by enabling businesses to transform and provide goods and services of increasing value**.'* (Commerce, Industry and Technology Bureau, 2006, p.3)

The document also outlined the actions for further consolidating the ICT cluster, including the following:

- To strengthen Cyberport and the Science Park as hubs for innovation and technology. To continue develop Phase Two of the Science Park (targeted to be completed in 2007 to 2008) to cater for the rising demand for technological infrastructure.

- To facilitate intellectual property transfer and commercialisation of innovation through the newly established R&D Centres.
- To provide focus and support to important ICT technologies including: (i) communications technologies, (ii) development of digital content; (iii) sensor and identification technologies; (iv) software development and packaging; and (v) next generation Internet.
- To establish channels to cooperate with Mainland authorities and Guangdong Province on innovation, information management and technological development.
- To upgrade the ICT workforce through strengthening training (Digital 21 Strategy, 2006).

To actualise the Government's 'focused', 'market-led' approach on ICT development after the 2004 consultation, the Government established the **R&D Centre for Information & Communications Technologies (R&D Centre for ICT)** with the objective of promoting applied R&D and facilitating technology transfer and commercialisation of four important ICT technologies—**communications technologies, consumer electronics, integrated circuit design and opto-electronics**. In view of the growing importance of 3G application and services, broadband wireless and ultra-wideband technologies, the Government decided to set up a **Wireless Communications Laboratory (WCL)** in the Science Park to provide support services such as pre-compliance tests and measurement for wireless technologies. Besides, the Government sponsored the Hong Kong Wireless Development Centre to set up a **TD-SCDMATP PT** (3G standard adopted in China) **test-bed** at Cyberport, the first trial site outside the Mainland, so as to encourage the industry to develop innovative 3G applications and services.

Apart from the R&D Centre for ICT, the work of R&D Centres in other technology areas was also closely related to the development of ICT. For example, the Radio-Frequency Identification (RFID) technology developed at the R&D Centre for Logistics and Supply Chain Management was closely related to ICT networking and infrastructure. Besides, ICT was also an enabling technology, underpinning the research on automatic navigation systems being undertaken in the R&D Centre for Automotive Parts and Accessory Systems. At the R&D Centre for Textile and Clothing, research uses ICT to enhance the dissemination of information on textile materials and clothing products. Last but not least, the R&D Centre for Nanotechnology and Advanced Materials was conducting industry-oriented research with the aim of improving the performance and functionality of next generation electronic products and devices, the result of which could make them smaller, cheaper and more reliable. In short, these five R&D Centres complemented each other in capturing the future trend of the convergence of ICT in different sectors in Hong Kong.

**Capitalising on the emerging ICT market in China**

China has been regarded as the largest emerging ICT market in the world. The Chinese Government has set a clear objective as part of its Five-Year Plan to strengthen innovation and upgrade the technology capability of industries. Hong Kong seeks to **participate in the Mainland's technology development plans** and the **formulation of national standards** through the Mainland/Hong Kong Science and Technology Cooperation Committee. Also, the **Guangdong/Hong Kong Technology Cooperation Funding Scheme** established in 2004 continues to provide financial support for R&D projects in technology areas of common interest, including ICT, in the Greater Pearl River Delta Region. The deepening of cooperation helps generate new dynamics to support the virtuous cycle of growth of the Hong Kong technology cluster, which is expected to lead to technology advancement and economic growth.

Table 5.11 Overview of alignment conditions of the Hong Kong technology cluster at the end of its evolution phase

| **State of alignment of the Hong Kong cluster at the end of its evolution phase** |
| --- |
| **(I) Constituents' Perceptions, Goals, Actions and Resources**<br>• At the beginning of this stage, the Hong Kong technology cluster faced a number of problems caused by the external environment, such as economic downturn, government deficits, the SARS outbreak, and public outrage with the Government. These factors were beyond the control of the cluster constituents and seriously affected the development of the cluster. In particular, the key Government constituent ran out of resources while the public shifted their support from technology development to demanding instant solution from the Government.<br>• The technology cluster lost its high policy profile as the Government dropped the goal of becoming 'an innovation centre of China and Asia.' Technology development only retained a subsidiary role for enhancing the competitiveness of the service industries which became the new high-profile focus.<br>• Not everything was negative news for the cluster constituency. Near the end of this phase, the Government initiated a comprehensive review of the technology cluster and established that, despite the fact that the cluster did not have a highly successful impact on the economy, it did help advance Hong Kong's technological capabilities. The Government carried out re-alignment measures to address the weaknesses. Though the impacts of the |

re-alignment efforts were still unknown, it was expected that the new strategy would help improve the overall technology cluster.

- Inside the cluster, facing the stringent budgets that resulted from cuts in public expenditure, the ITC announced the adoption of a 'focused' approach to technology development with more resources deployed on technology areas in which Hong Kong has an edge. As a result, ICT became one of the target areas and won privileged support.
- A renewed 'market-pull' approach was also launched as part of the realignment at the end of this phase, given that industry found that the 'technology push' approach was not beneficial to industrial innovation (45% of research results were impractical). This 'market-pull' approach may enhance the impact of the technology programmes. The Government began to pay more attention to the 'needs' of the industry in the technology cluster. The Government also decided to improve the communication with the cluster stakeholders through the consultation process. The cluster constituents took part in the selection of the technology focuses for the R&D Centres and the Government also facilitated cooperation among the industry and the research institutions through the R&D Centres.
- In this phase, the constituents of the Hong Kong technology cluster successfully aligned their technology interests with those of target constituents from China. Given that China was the largest ICT market in the world and the Chinese Government was also determined to support technology development in its Five Year Plan, Hong Kong could exercise leverage on the resources in China (through forging partnership and cooperative funding schemes) to drive the further development of its technology cluster.
- Near the end of this phase, two leading cluster-champions left the constituency building process, with consequent loss of authority and leadership. The new Chief Executive did not particularly support the technology development strategy. As a result, the technology cluster seemed less important to both the Government and the mass media.

**(II) Nature and Maturity of the Technology**

- The content of this dimension remained very much the same as with the previous phase. However, at this stage, the Government clearly set the technology focus for the cluster. Regarding ICT, the target technologies included communication technologies, consumer electronics, IC design and opto-electronics. These technology areas were in alignment with Hong Kong's technology capabilities and also in line with the latest technology trends and interests of the Chinese Government. Therefore, Hong Kong could leverage China's resources to further develop these technologies.
- The convergence trend of ICTs was expected to play in favour of Hong Kong, given that necessary infrastructure has been put in place in the Science Park and Cyberport, R&D talents have been recruited from China and the Government was making efforts to build a favourable regulatory regime and supporting framework through its Digital 21 Strategy. In particular, Hong Kong ICT companies had to prioritise ICT technology areas where China

had a growing demand, such as RFID, automotive parts and accessory systems, and IC design. This required Hong Kong ICT companies to advance quickly to obtain the 'first mover' advantage to tap into the Chinese ICT market.

- In this respect, the participation of Hong Kong in developing ICT standards in China, such as China's 3G standard also gives advantages to Hong Kong ICT companies over other foreign companies to penetrate into the largest ICT market in the world.

**Alignment (1) Governance**

- During this period, the alignment of the cluster constituency with the governance at government policy levels weakened visibly. Amongst the causes, were the unresolved economic crisis, the SARS outbreak and the serious fiscal deficits that revealed serious deficiencies in the concept and implementation of the Government strategy, leading to a loss of credibility. In addition, the Government had to cut public expenditure due to its huge fiscal deficits and was unable to mobilise the public to support its technology development programmes. The Government shifted the overall direction of its economic policy to support the service industry. This direction was supported by the Chinese Government who recently opened the market of its service industry to overseas participation.
- The departure of two leading cluster builders from the technology cluster compounded the weakening of alignment between the cluster constituency and the governance at government policy levels. The new Chief Executive did not favour a technology development strategy.
- New governance structure and mechanisms were required due to the geographical enlargement of the technology cluster to China and Pearl River Delta. Though Hong Kong could benefit from the resources of China, Hong Kong also faced direct competition from different regions in China. The Hong Kong Government had to maintain a balance in these cooperative-competitive relations (see Dimension 4 below).

**Alignment (2) Nature of Target Problem**

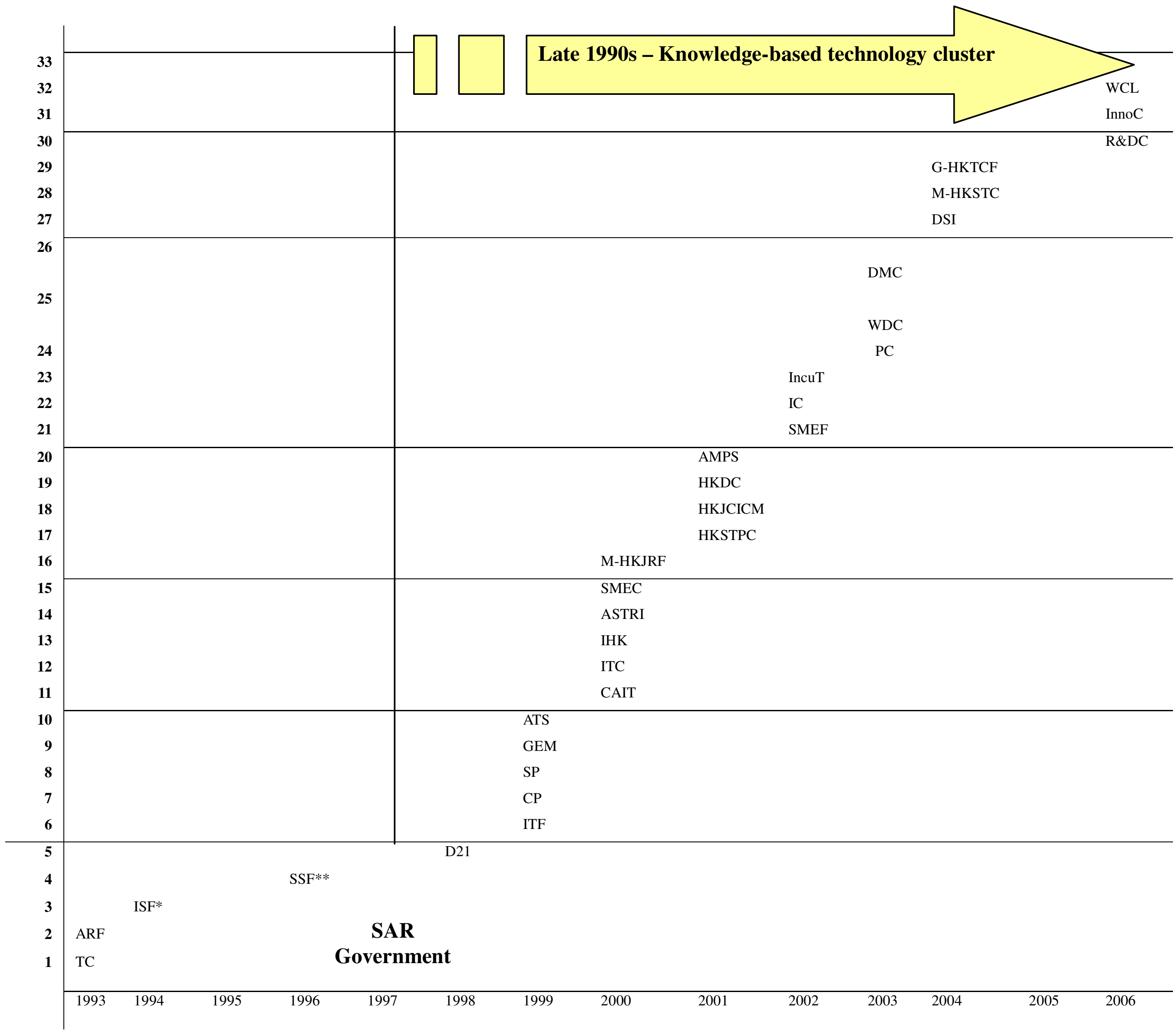
- The nature of the target problem at this phase remained largely the same as stated in Table 5.7. Although over the years, the technology cluster has achieved some success, such as increased R&D expenditure and improved R&D output, these impacts were still far too small to be noticed, let alone transform the traditional manufacturing sector into an innovative, knowledge-intensive and high value one.
- In fact the target problem became more complex to achieve as Hong Kong was in deep economic troubles and the public demanded instant solutions. The public pressure actually forced the Government to drop the technology development strategy and revert to supporting the services industry. The lack of consistency and commitment from the Government sent a negative signal to industry, affecting their willingness to invest further in technology development (see alignment 1 – Governance)

| |
|---|
| • On the other hand, the presence of China as the largest emerging ICT market in the world opened new opportunities. |
| **Alignment (3) Target Constituents' Perceptions and Pursuits**<br>• Important target constituents of the technology cluster at this stage were foreign technology companies. The process of aligning more foreign companies to the cluster was favoured by Hong Kong's unique position as the gateway to China, as well as the CEPA and the effort of Invest HK to promote the HK-PRD formula.<br>• Other important target constituents were companies and skilled people from mainland China. Here, Hong Kong was regarded by Mainland enterprises as an ideal platform for their global expansion and the Chinese Government encouraged them to invest in Hong Kong due to its financial and legal infrastructure which could help them 'going global'. The Hong Kong Government tried to facilitate this process through policy measures.<br>• The Government attempted to attract mainland talents to work in Hong Kong. However, the numbers attracted did not match the original expectations. In view of this, the Government relaxed the restrictions and by 2006 over 10,000 talents have been approved to work in Hong Kong.<br>• To facilitate the alignment of multiple target constituents, the Government established new technology targets and R&D Centres. This implied that new companies, both local and overseas, mature or start-ups, would be included in the new technology cluster, as well as new research institutions, funding companies and networking bodies.<br>• Also, new cooperative agreements with China meant that new Government bodies, academia, industrial members and capital sources from the two places would be involved in the technology cluster. |
| **Alignment (4) Interacting Technologies/Constituencies**<br>• As seen in Dimensions I and 1, the Government, in 2003, announced a new policy direction to support service industries with technology in a subordinate role. As a result of this, the resources available for the technology cluster would inevitably decrease, especially as the Government was facing serious budget deficits at that time.<br>• The Hong Kong technology cluster sought integration with other technology clusters in China. The combined advantages of Hong Kong and PRD helped attract foreign investment, but the two places also competed with each other for inward investments, capital and labour.<br>• The four R&D Centres were complementary with the R&D Centre for ICT in Hong Kong. The five R&D Centres reinforced each other and strengthened Hong Kong's R&D capabilities in ICT.<br>• The opening of China after its accession to the WTO meant that many foreign companies were in direct competition with Hong Kong in the PRC market. Many of these foreign companies were part of technology clusters in their respective home countries. This implied that the Hong Kong technology cluster was indirectly interacting/competing with other overseas technology clusters. |

Figure 5.3 illustrates the evolution of the Hong Kong Government's build up of institutions and mechanisms aimed at nurturing the growth of the knowledge-based technology cluster. It shows how this build up has accelerated starting in the late 1990s in an effort to cover all areas perceived to be necessary to reach a critical mass and induce a 'virtuous cycle' of growth.

**Cumulative Number of Initiatives**

Figure 5.3 Evolution of the cumulative number of the Initiatives for the Hong Kong technology cluster




* ISF terminated in 1999, replaced by ITF

**SSF terminated in 1999, replaced by ITF

## 5.3 Evaluation of Hong Kong's technology cluster

### 5.3.1 What did the Hong Kong technology cluster achieve?

In 1998, the Chief Executive of the Hong Kong SAR Government set out a vision to make Hong Kong '*an innovation centre of south China and Asia*' in his Policy Address. It was obvious that by the end of 2006 Hong Kong had not yet realised its vision. However, when taking a closer look, some achievements could still be found within the cluster. Below is an assessment of the contribution of Hong Kong's cluster strategy in relation to: 1) increasing resources 2) enhancing/fostering relationships 3) strengthening technological capabilities 4) achieving governance 5) impact on the local economy.

**1. Increasing institutional channels and resources**

One of the greatest achievements of the Hong Kong cluster strategy was the creation of a number of institutional channels and resources. Institutional infrastructure, such as the Innovation and Technology Commission (ITC), the Applied Science and Technology Research Institute (ASTRI), the Hong Kong Science and Technology Park Corporation (HKSTPC), the Growth Enterprise Market (GEM), and physical infrastructure, such as the Hong Kong Science Park (HKSP), the Cyberport (CP), the Photonic Centre (PC), and the IC Development Centre (IC), were set up to fulfil their special roles in the cluster. Many of these structures would not have existed without the cluster strategy. The setting up of formal institutions to oversee the technology policies in Hong Kong gave the technology cluster the crucial leadership that guided its development. Besides, physical infrastructures such as the Science Park and Cyberport successfully attracted a number of ICT companies from overseas to locate in Hong Kong[69]. The ICT support centres also provided essential equipment and technical support to ICT companies. Given the high structural costs in Hong Kong, these new institutions helped reduce the operational cost for some ICT companies and lowered entry barriers for many ICT start-ups. As a Manager of a foreign IC design company said:

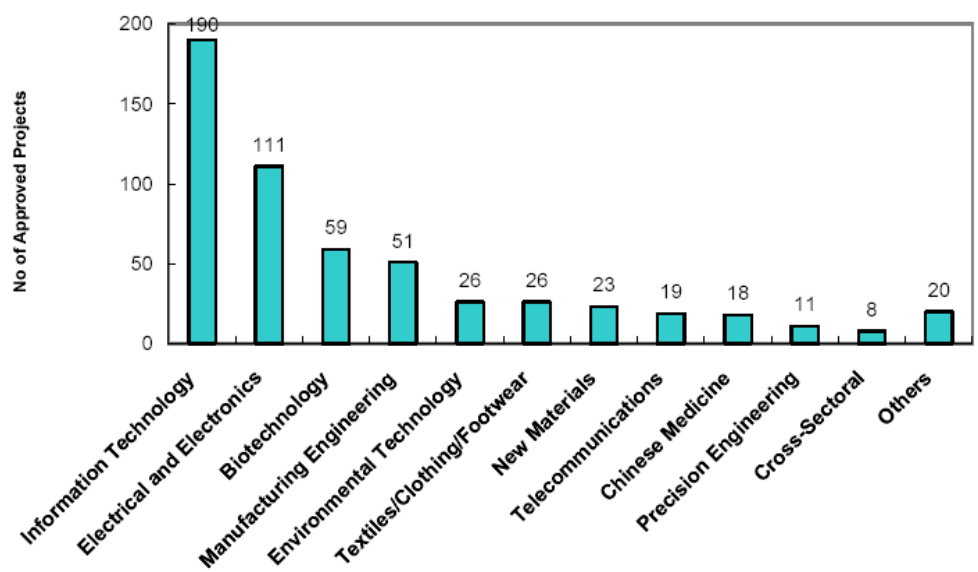
> *'The Science Park offers a lot of common facilities, particularly for the semiconductor industry, and because we can share this very expensive equipment with other tenants we don't have to buy something we don't often use'*

The funding schemes set up by the Government also provided essential financial resources for technology companies. According to the Innovation and Technology Commission's figures, at

[69] These foreign ICT companies include Pericom, REnex, Analogic Tech from the Silicon Valley in the US and prominent MNCs such as Microsoft, GE Information Services, and Sonera.

March 2004, the ITF had supported 562 projects at about HK$1.53 billion. Amongst these, 331 projects were related to ICT (see Figure 5.4). The ITF also encouraged the business sector to invest more financial resources in R&D activities through the provision of a matching grant. As Innovation and Technology Commission's data showed, before the introduction of the programme in 1999, the total amount of private sector contribution to R&D was only HK$24 million per annum, contrasting with an average of HK$177 million per annum after the introduction of the ITF. (Innovation Technology Commission, 2004a)

Figure 5.4 Sectoral breakdown of the 562 approved ITF projects as at end March 2004 (source: Innovation and Technology Commission, 2004a, p.4)

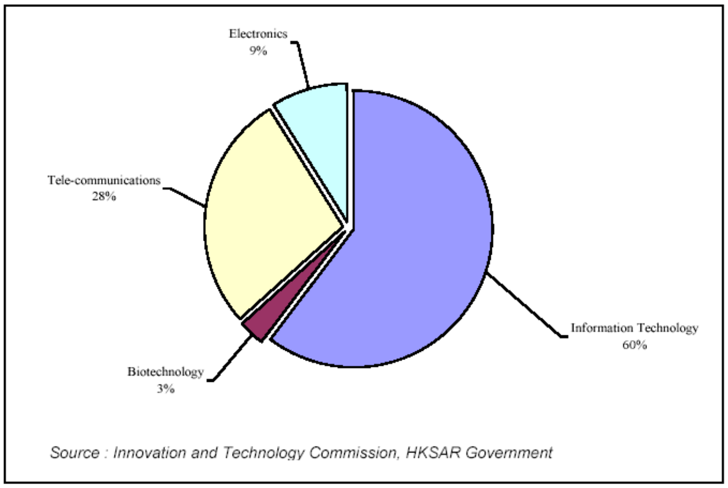



The industry-university cooperative programme under the ITF also encouraged industry to contract out their research to universities by giving them financial incentives, without which industry would have probably not considered carrying out their research with the university. Below are the comments from a Manager of a foreign IC design company:

> *'My company participates in the ITF. We cooperated with [University S] in a few projects…Although we have to contribute a certain amount of money to the project, the Government subsidises part of it, that means we don't need to pay for the whole project and this can help reduce our R&D costs. R&D is very important to our industry and it always costs a lot of money. If we can obtain external funding, it will lessen our burden.'*

Apart from the ITF, the ARF provided seed capital to start-up technology companies in Hong Kong. By the end March 2004, the ARF had supported 23 projects through fund managers with an approved funding of HK$378 million. As Figure 5.5 shows, 97% of the ARF was awarded to companies engaging in ICT.

Figure 5.5 Sectoral breakdown of projects funded by the ARF as at end March 2004 (source: Innovation Technology Commission, 2004a, p.5)




As described in Appendix 6, although a large number of VC companies are present in Hong Kong, they seldom invest in local companies. One of the criteria for receiving the ARF is that the investing company should be based in Hong Kong. In other words, the ARF increased the availability of venture capital, which would otherwise have being invested in other countries, to Hong Kong companies. An interviewee, who is a CEO of an information management company and is close to the fund managers administering the ARF, said of this:

> *'After they [venture capital company W] have administered the Applied Research Fund for the Government, they started employing more people in Hong Kong and investing in Hong Kong companies because the ARF must be invested in Hong Kong…'*

In addition, the statistics from the Innovation and Technology Commission showed that the GERD of Hong Kong, as a percentage of GDP, has increased from 0.44% in 1998 to 0.6% in 2002, amounting to HK$7.5 billion. The total expenditure on in-house R&D activities in the business sector amounted to HK$2,506 million in 2002. The ratio of business expenditure on R&D increased from 0.12% in 1998 to 0.2% in 2002 and this trend is expected to continue in future years. (Innovation Technology Commission, 2004a, pp.6-12) All this implies that the financial resources available for technology development, both from the public and private sources, increased after the introduction of the cluster strategy.

The human resources available in Hong Kong for technology development increased after the launch of the cluster related programmes. According to the figures from the Innovation and Technology Commission, the number of R&D personnel employed by commerce and industry increased by 43%, to 12,890, from 1998 to 2002. The ASTRI has become a focal point to attract young researchers and scientists and about 100 R&D talents have been recruited to work there for various research projects. The Science Park and Cyberport also helped attract talents from all over the world. About half of the 143 tenants of the Science Park are from overseas and China (Information Services Department, 24 October, 2006) and many of them brought senior engineers or research personnel with them from their countries.

The cluster strategy enhanced the knowledge resources available to technology companies. Over the years, the Government proactively organised or sponsored seminars, exhibitions, symposia, forums and workshops of all kinds based on different technology themes[70], all these helped stimulate discussion and the exchange of ideas and opinions about important technology related issues among the different stakeholders of the technology cluster. The Government also from time to time, invited prominent scholars from local and overseas universities to give talks and seminars about the latest development of a particular technology, and this helped Hong Kong technology companies to keep abreast of the latest technology trends.

**2. Enhancing/fostering relationships**

With regard to the enhancement of relationships among different cluster stakeholders, the technology cluster did not achieve a lot. This was particularly the case for the commercial networks between users and suppliers. As mentioned in earlier sections, companies in Hong Kong did not have an integrated local supply chain[71]. Due to the small local market and the high local material costs, technology companies mainly served overseas customers and procured from foreign suppliers. Consequently, they did not have any incentive to network with each other because they did not share the same commercial interests. Although the Government constructed the Science Park and Cyberport, hoping that co-location of technology companies in the same field would help foster relationships among them, many interviewees stressed that their location was not of high importance in building relations, given the well developed telecommunication networks in Hong Kong. Rather, it was the

[70] Past conferences held in HK included topics like commercialisation of technologies, technology opportunities in China, and e-commerce for SMEs, etc.

[71] They mainly use local suppliers for low-value, non technical items and import high-value added components from overseas suppliers.

existence of business opportunities that drove them to network with one another. The Vice President of a local bio-informatics company spoke about this:

> *'We don't think locating together with other technology companies is important to us. I think technology companies or IT companies should be close to their customers. I don't think locating in the same area with other technology companies will help our business as their businesses may not have any relation to ours…'*

The lack of commercial networks among ICT companies in Hong Kong also inhibited the development of knowledge networks amongst them. This was not only because ICT companies thought that commercial networks were more important than knowledge networks, but also because they regarded the existence of commercial networks as a pre-requisite for knowledge networks. The Director of a local photonic company observed:

> *'…to promote a technology industry, it is economic rather than technological factors which are important…The largest output of technological intellectual property is in Silicon Valley, which is because the market is there…'*

As said in Appendix 6, the Government's attempt to encourage industry-university relations did not generate very satisfactory results, due mainly to the different interests and cultures between the two kinds of organisations. As one interviewee who is the Vice President of a bio-informatics company said:

> *'I think the largest problem is that the university is a very academic organisation. We are not looking for fundamental research, but very practical product building or application building. I think the university is unable to catch up [the speed of the industry], their professors are not dedicated to doing one thing…'*

Many ICT companies interviewed disagreed with the Government's 'technology push' approach to encourage innovation and technology development. They thought that such an approach would not achieve any results unless the Government began to pay attention to the importance of commercial networks amongst companies. The above interviewee continued:

> *'I think the Government's thinking is different from us. They pay a lot of attention to the linkages with universities, they seldom pay attention to business and marketing. In fact, the success of a company actually depends on these two…'*

In order to improve the industry-university networks, the Government tried to enhance the understanding of the two types of organisations through less formal activities. Instead of simply focusing on more high level cooperation between the two, such as joint-research or contract research, the Government encouraged more interaction among them through student level and instrumental level activities. For instance, the Government gave financial incentives to companies to encourage them to take on university students for short-term placement through the Teaching Company Scheme[72]. The Government also negotiated on behalf of the industry to persuade several universities to open their libraries and laboratories for company users. These small steps helped improve communication and understanding between the two organisations and paved the way for a deeper level of cooperation in future. As one interviewee from the university technology transfer office said:

> *'The Science Park will allocate some money to subsidise collaborative projects between their tenants and the university. Its aim is to 'break the ice' between the industry and the university. We introduce our professors to them so that they can get to know each other and work together in different projects.*'

Social networks played a role in helping develop and strengthen commercial and knowledge networks among the stakeholders of the cluster. Although there was no evidence to prove that social networks among ICT companies have strengthened after the launch of the cluster strategy, it was obvious that ICT companies had more opportunities to gather together to attend the seminars and activities organised by different trade associations and the Government. Sometimes, these informal meetings might lead to the formation of commercial and knowledge networks. As one interviewee, who is the Chairman of an ICT networking organisation explained:

> *'Like the activity we organised, we got about 30 companies from the industry to attend. These people network with each other and they may become business partners. They look for business opportunities in casual social occasions...'*

**3. Strengthening technological capabilities**

The strengthening of the technology capabilities of Hong Kong companies was evident after the introduction of the cluster strategy. The report from the Innovation and Technology Commission showed that local companies have made progress in the application of new and advanced technologies. Between 2001 and 2002, the total number of local enterprises engaged in R&D grew from 887 to 1,223, representing an increase of 38%. Also, according to a government survey[73], each ITF project has on average generated 1.3 technologies or products, 0.55 and 0.15 patents have been filed and granted per project, respectively. The

[72] The Teaching Company Scheme enables university students to work at a technology company through the sponsorship of the HKSTP which covers part of the costs.
[73] The survey, aiming at reviewing the impact of ITF, was conducted by the Government in December 2003 to January 2004 by means of a self-administered questionnaire. The survey results were based on the response to 1,071 questionnaires.

above survey also revealed that 71% of the respondents agreed that the ITF could help upgrade the technology level of Hong Kong. The number of patents filed at US Patent & Trademark Office (USPTO), as an indication of the overall technological capabilities of Hong Kong organisations, increased from 395 in 1999 to 667 in 2003. (Innovation and Technology Commission, 2004a, p.10-11)

In spite of this progress, the number of companies engaging in R&D was still small, since over 500,000 companies registered in Hong Kong, and the dominant majority of them did not engage in any R&D activities. Besides, according to United Nations Educational Scientific and Cultural Organisation's (UNESCO) figures, the average GERD, as a percentage of the GDP of Asian countries in 2002, was 1.5%.(UNESCO, 2004) The corresponding figure for Hong Kong in the same year was 0.6%, showing that Hong Kong was still lagging behind many Asian countries in R&D investment.

**4. Enhancing governance**

The introduction of the cluster strategy helped strengthen the governance of technology development. Prior to the launch of the cluster strategy, the Government only appointed a special commission or consultancy company to give advice on matters relating technology development when necessary. However, the Government seldom followed up a report or proposal. As mentioned, after the formal announcement of the cluster strategy, a number of institutions were created and given responsibility for supporting innovation and technology development. This helped strengthen the governance structure of the technology cluster. Besides, the Government recruited leading industrial experts to take part in technology policy design and implementation (i.e. appointments of Mr. CD Tam and Mr. Carlos Genardini from Motorola to be CEO of HKSTPC). This helped improve the technological knowledge and capabilities of the Government. However, the resignation of Chief Executive Chee Hwa Tung, the chief architect of the technology cluster, tended to weaken the governance of the technology cluster, especially as the main policy of Mr. Donald Tsang, the new Chief Executive, was to support service industries. It was questionable whether the Government would sustain its commitment and high level support to the technology cluster.

At the same time, the market governance of the technology cluster had been strengthened due to the cooperation of the local trade associations, as well as the successful implementation of the Digital 21 Strategy. With regard to the former, these trade associations were influential in encouraging their members to support the technology cluster. They also from time to time took initiatives to conduct or commission research with the aim to find ways to improve Hong

Kong's technology industries, including the ICT. The growing importance of the market governance given by these trade associations was reflected in the consultation exercise mentioned in section 5.2.4, in which the policy makers pro-actively sought advice from them and involved them in defining the future technology strategies of Hong Kong. With respect to the latter, a favourable innovative culture, or milieu, has been fostered by the Digital 21 Strategy, in which the promotion of education and utilisation of ICT by the Government helped improve the general awareness and application of ICT in society. For instance, the PC penetration rate in business increased from 55% in 2003 to 60% in 2005, with over 50% of the businesses adopting some form of e-business. (Commerce, Industry and Technology Bureau, 2006, p.10) The favourable technology culture also helped reinforce the market governance of the technology cluster.

**5. Impact on local economy**

Since the Hong Kong technology cluster was still in its early stage it was hard to measure its impact on the local economy. Yet, some indicators reflected its economic contribution. For instance, infrastructure projects like Cyberport and Science Park have successfully attracted a number of inward investors to Hong Kong. Looking at the Science Park alone, there were 143 companies and half of them were inward investors. The incubation programme operated by the HKSTPC also helped incubate 50 start-up companies at the Science Park. Altogether about 4,000 jobs have been generated and many of them were high skilled jobs. (Information Services Department, 24 October, 2006) Also, according to Government data up to 2006, ASTRI transferred 37 pieces of technology to the industry. One of the projects involved the development of a piece of technology to enable interactive learning of spoken English on the Internet. Upon the completion of the project in 2003, this technology has been successfully licensed to several local companies for developing various hardware and software educational products. In addition to the above, the ASTRI recently has completed three projects on photonics packaging technology, which generated a license fee of more than HK$109 million for ASTRI. (Innovation and Technology Commission, 2004a, p.6)

Yet the impact of the ICT cluster should not just be measured by traditional economic indicators, such as the amount of investment received or number of jobs created. The development of a piece of technology might lead to the creation of a whole new business or bring benefits to the society at large. This kind of impact on the economy is long term and sometimes intangible.

### 5.3.2 Problems with the Hong Kong technology cluster

#### 1. Problems with the environment

#### a. Problems with the economic environment—set in a bad timing

The biggest weakness of the ICT cluster was the timing. The Government started its cluster building process in 1998, with an attempt to capture the emerging opportunities of the global IT boom. However, in 2001, Hong Kong was hit by the worldwide economic recession and the global ICT down cycle. As a result, the economy of Hong Kong underwent a downturn for a few years after 2002. The GDP declined, a lot of companies downsized and laid off their staff. The ICT industry was no exception to this trend. Instead of an increase in the number of ICT companies and workforce, one interviewee, who worked for the government industrial supporting organisation, estimated that the number of ICT companies and employees actually dropped about 10% and 20% respectively during the down phase.

In this economic environment, ICT companies were constrained by a lack of resources and capital to invest in innovation and technology development activities. In particular, developing technology is a lengthy and uncertain process, and ICT companies logically became more reluctant to take a risk as they were uncertain of the economic prospects. The following quotes by two interviewees, one from a local electronic manufacturing company and the other from a wireless communication company, showed how much 'timing' shaped the impact of the cluster strategy:

> *'Under this economic situation, it can be said it is a blessing if a company is still running. They won't think of moving to the Science Park to capture the cluster effect…'*

> *'If the Government would have constructed the Park four years ago, they would have captured the good economy at that time. Now the economy is bad, the impact of the Park would be very different…'*

#### b. Problems with the industrial environment—mis-alignment with the industrial structure

The small technology base of Hong Kong became another impediment to the cluster building process. As said in Appendix 6, the ICT sector of Hong Kong had the following structural characteristics 1) small in numbers (only 763 ICT manufacturing companies in Hong Kong); 2) low technological capabilities (mainly engaging in OEM and without significant R&D

capabilities); 3) dominated by SMEs (the average size of IT company in Hong Kong was 19 employees) and were constrained by limited financial and human resources; 4) many of them simply engaged in trading ICT products or providing technical support services. In short, the industrial constituents of the Hong Kong ICT cluster were relatively ‘weak’ and they restricted the growth and development of the ICT cluster for two reasons:

Firstly, the small technology base meant that the critical mass for generating the cluster effect never developed. An interviewee who was from an information management company talked about this problem:

> *‘If you add all the R&D people who work in the small companies together, the number won’t exceed 1,000 people. For the companies I’ve known, they only have a maximum of 10-20 people working on something related to R&D. If you put all these R&D people, together with their sales and marketing people to the Science Park, the number will be about 3,000. It is still not enough to form a critical mass. The industrial structure is too fragmented and it’s difficult to form a core...’*

Secondly, the small technology base inhibited the network building among ICT companies, as Hong Kong did not have a fully developed chain of firms which could collaborate between themselves. In fact, each technology firm was specialised in a particular technology area and complementarities with each other were lacking. An interviewee, who is a senior government official and a leader of the ICT cluster, described the situation in Hong Kong:

> *‘If you want to find a technology partner in Hong Kong, there are only a few choices. Though I’m not in the industry, if you ask me who are in the semiconductor industry in Hong Kong, I can name them all, there are only a few…. You can’t expect that two different companies who come together will automatically have a positive engagement. The most important thing is complementarities and synergies…’*

**c. Problems with the technology environment—lack of critical mass of leading technologies**

The Government’s effort to build a technology cluster was hampered by its mis-alignment with Hong Kong’s technology environment. As noted, the Hong Kong’s ICT industry was mainly OEM based with low added value. The process involved to upgrade it to a knowledge-based industry with a high technological input was complex and difficult. Hong Kong traditionally was a service-based country and was not strong in any particular technology, except for the application of modern technologies. There was no truly global competitive technology in Hong Kong for the ICT cluster to build on. One interviewee, who is a Vice President of a venture capital firm, talked about this:

> *'You could say Hong Kong has a base for the software industry, but to be honest, Hong Kong is not particularly strong in this area. If you said Hong Kong is strong in semiconductors, absolutely not, Taiwan is much better. You may think of telecommunication, wireless, mobiles, but Hong Kong is not strong in these areas, even though we have many mobile service providers…In terms of a truly competitive technology, there's none…'*

Without a competitive technology sector to build on, the constituency building process of the ICT cluster became extremely difficult as the Government almost had to start everything from scratch, including attracting foreign ICT companies, bringing in technology talents, nurturing technology start-ups, encouraging collaborative networks among companies and universities. An interviewee, who is a Managing Director of a venture capital company, explained this:

> *'The government should try to encourage when things exist. It's tough to invent a technology sector that didn't really exist. The theory of a cluster is that you build on the momentum because the connections create the velocity of idea, flows of capital and concepts of business plans, but at least you need something there for the catalyst to work on…'*

Besides, the government's technology push approach was mis-aligned with the technology trends facing the ICT industry of Hong Kong. As mentioned in a previous section, the most important products of Hong Kong's ICT industry were consumer electronic products and electronic components. For the former, technologies were very much driven by customers and market demands. For the latter, customisation, specification and configuration were important dimensions in order to perform 'inter-operative' functions. Therefore, industry-driven networks with suppliers and customers, were of high importance to the development of these technologies. Unfortunately, the Government overlooked the nature of the ICT technologies and their key approach was to encourage industries to cooperate with the universities. As a result, the cluster programmes failed to meet the industry's needs. It seemed that the Government began to realise this problem at the later stage of the cluster development. When they embarked on the re-alignment programmes, they put much emphasis on the 'market-led' approach in their new strategy.

**2. Problems with the Government**

**a. Relatively insufficient support compared to neighbouring countries**

The insufficient support from the Government not only made it difficult for Hong Kong's ICT companies to compete with other neighbouring countries, but also created problems for the constituency building process of the ICT cluster. As a number of interviewees pointed out, governments of other countries would give generous incentives to motivate relevant stakeholders to engage in their technology cluster. For example, China provides cheap land, Singapore gives tax incentives, Korea invests directly into technology companies and Taiwan provides huge research funding for targeted technologies. However, for the cluster of Hong Kong, the incentives (in the form of funding or infrastructure support) given to the industry were small compared to other countries. As a result, the Hong Kong Government had difficulties in motivating the social constituents to take part in the constituency building process of the ICT cluster because they did not see much benefit to be gained by being a part of it.

**b. Problems with the Government's leadership**

**i) Too ambitious and lacking focus**

Many interviewees also pointed out that the Hong Kong Government lacked focus in its technology policies. The problem was twofold: first, the Government was too ambitious and they tried to develop many different technologies at one time; second, the Government initiatives were mainly targeting all industries for general purposes, so that the level of support was diffused. The Government's lack of focus on technology development not only confused the cluster stakeholders about the direction which the Government intended to pursue, but also diluted the resources available for the ICT cluster. The following are the comments made by three interviewees. Two are from the university technology transfer offices and one from a foreign software company:

> *'The Government wants to create a technology cluster, but what kind of cluster do they want to create?... They have to define what is the main direction of our knowledge-based economy, select the key industrial sectors they want to promote…and invest resources in these key sectors, not just investing in a piecemeal way...'*

> *'I think the problem of the cluster is lacking of focus. Hong Kong tries to develop so many industries at one time, such as Chinese medicine, biotechnology, information technology, etc., but without a clear focus, it will be very difficult to identify the niche of Hong Kong and attract inward investors.'*

> *'What is the focus of the Government? What do they want to promote? Is it property development, financial services, information technology or Chinese medicine? I think many people in Hong Kong don't know what the Government's direction is. The Government hasn't developed a clear focus for their policies….'*

**ii) Lack of long term commitment**

There is no doubt that pursuing technology development is a lengthy and risky process. Without long-term support and encouragement from the Government, it was difficult for a Hong Kong company to conduct R&D in a persistent, long term manner. Yet a number of interviewees from the industry showed their lack of confidence in the Government's commitment to support technology development. Below are the words of a few interviewees from the university technology transfer office, the government and a local IC design company:

> *'One of the problems of Hong Kong is that people are too short-sighted. …What I worry about the most is the commitment of the Government. If the people can't see the results [of technology development], they may become frustrated and the Government will retract their support.'*

> *'I think the most important thing is the Government's commitment, policy and support to ensure that all the initiatives and whole project [of the Science Park] can keep going on a sustainable basis. Otherwise, if the Government say, it's been three years, hands off, then they are not going to do anything and it would be a great problem…'*

> *'I think the problem is about the commitment of the Government that they may not give enough time for the [Science] Park to develop. Surely the Government will provide the first funding. If the results are not up to their expectation, they may de-emphasise the Park and move to do something else…'*

**c. Problems with the execution of the initiatives**

**i) Slow in action**

Many interviewees felt that the Government was too slow in implementing the technology policies. As the previous section showed, the idea of building a technology cluster was initiated in the early 1990s, but the Government adopted a 'wait and see' attitude and did not put the idea into action until the late 1990s. A price has been paid for the Government's delay, for Hong Kong ICT companies missed the opportunities during the global IT bloom and lagged behind other Asian countries in developing technology industries. Two interviewees, who are from a local IC design company and a research institute said:

> *'They [the Government] are very slow in action. They spend too much time on discussion, but take no action. We are glad that they finished the Science Park, they have been talking about it for many years…'*

*'I believe the Government has plenty of resources, but their action is very slow. The implementation of the policies is so slow that it cannot keep up with the pace of the industry. We hope the Government's support can deliver quicker…'*

**ii) Bureaucracy and red tape**

As mentioned in the previous section, some of the supporting initiatives launched by the Government did not achieve satisfactory results. For example, the number of applications for the ITF and the Admission of Mainland Professionals Scheme was quite low. According to the interviewees, one of the reasons that contributed to this was the Government bureaucracy and red tape. The complication of the application process and the 'micro-managing' attitude of the Government towards the applicants of these programmes stopped many organisations from seeking help from the Government. The following are the comments from two interviewees:

*'Once we applied for a work visa for one of our colleagues from the US to work here, but the work visa is very difficult to get. We have to provide a lot of documents and to go through so many procedures…' (General Manager of a foreign software company)*

*'To be honest, the application procedures [for the government fund] are very complicated and troublesome. We have to be very cautious throughout the project…The Government asked our staff to provide all the evidences about their spending and compile reports about every tiny detail. It is very time consuming. Therefore, we don't apply for it anymore… ' (Manager of a foreign IC company)*

**3. Problems with the participants**

**a. Participants' lack of knowledge about to the cluster strategy**

**i) Neglect of the goals and objectives**

The first reason contributing to the problem was the poor communication between the Government and the stakeholders about the goals of the technology cluster. An understanding of the aims and objectives of the cluster was essential for maintaining the alignment of the stakeholders' goals, perceptions and actions with the government's goals. However, in the case of Hong Kong, although the Government publicly announced the vision of developing Hong Kong into an 'innovation centre of Asia', many interviewees admitted that they did not know about the Government's goal. Since the stakeholders were ignorant about the goals of the technology cluster, they could not relate themselves to the cluster and give appropriate support to the cluster initiatives. The following quotations showed that the goals of the technology cluster were unknown to many stakeholders:

*'We need a common goal, but at this stage I'm not so sure what the goal of our Government is…' (Manager of a university technology transfer office)*

*'Their [the Government's] vision is not very clear. What do they want to achieve at the end? I don't know…' (Vice President of a local bio-informatics company)*

In fact, the Government had a part to play in causing this problem with the stakeholders. Although a very 'grand' vision of becoming the 'innovation centre of South China and Asia' has been set for Hong Kong, the Government has not defined specifically what they wanted to achieve. No specific or measurable target or timetable has been set. The ambitious, yet ambiguous, vision of Hong Kong confused the public and they did not know how to support or to assist the Government to achieve the vision. One interviewee, who is Vice President of a local bio-informatics company, said the following:

*'They have a very 'grand' objective. It is to make Hong Kong an innovation centre in Asia. However, the objective is so 'grand' that we don't know how to achieve it…'*

**ii) Lack of perception about practical involvement**

The constituency building of a cluster required collective participation from a wide range of stakeholders. However, many stakeholders did not understand 'clusters' well enough to know what kind of action was needed from them to build one. To many of them the term 'cluster' was simply a 'buzzword', which means the agglomeration of high-tech companies in such places as 'Silicon Valley'. They did not realise that they were in fact meant to be part of a cluster and their active participation and contribution was the key to its success. Since they did not perceive that they were participating in the constituency building process of a technology cluster, nor they had strong commercial complementarities, they did not modify their attitude and behaviour in order to even try to start innovating, learning and networking with each other. Two interviewees, who are from a government industrial support organisation and a local mobile entertainment company, described the situation in Hong Kong's cluster as follows:

*'The companies move to the Science Park just because they want the cheap rent and the supporting facilities there. They haven't thought about clustering…'*

*'I don't think the Technology Centre can achieve this [clustering]. Technology companies came here because the Government offer money and land, but they are only doing what they want and they don't have any technology flow among each other. They just enjoy the resources…'*

**b. Disagreement over the goals and means of the cluster strategy**

**i) Disagreement with the Government's goals**

While the Government's vision was known to some stakeholders it did not mean that they agreed with it and would join to work towards its fulfilment. In fact, many stakeholders thought that the vision was not suitable for Hong Kong. Quoting one interviewee, who is a Managing Director of a foreign venture capital company:

> *'I think it [the goal] is misguided because I don't think Hong Kong will have a strong IT industry in the future. My personal view is that the IT evolution in Hong Kong should support the businesses that are here, rather than trying to be a regional hub for, or a regional leader in IT. I don't think Hong Kong has the necessary skills or manpower to be a leading IT centre…'*

**ii) Disagreement with the Government's means to develop a technology cluster**

Although some stakeholders supported the Government's overall objectives to develop a technology cluster, they disagreed with the Government's means to achieve it. The inability of the Government to balance the interests from different stakeholders hindered the cluster's development. For example, some stakeholders objected to the Government's plan to attract overseas technology companies to locate in the Science Park. The following two quotations, one from a Director of a local mobile entertainment company and the other from a Vice President of a local bio-informatics company, explicitly spelled out the conflict of interests between the local and the overseas companies:

> *'The Government is using public money to subsidise the big foreign companies. These foreign companies will move away after they use up our resources. They cannot help Hong Kong's industry. The creation of Hong Kong Science Park cannot help the industry because it only adds wealth to the rich companies...'*

> *'I think the Science Park should focus on helping the local companies instead of the foreign companies. If the Government wants to develop technology industries in Hong Kong, they should focus on cultivating the indigenous companies…'*

**4. Problems caused by the interacting constituencies—Competition from China**

The above mentioned problems faced by the technology cluster were mostly located within Hong Kong, yet there were some problems affecting the cluster that were beyond Hong Kong's control, such as the competition from other economies. One of the biggest threats of Hong Kong's technology cluster actually came from China. As said, the importance of Hong

Kong as being a 'stepping stone' to China was declining due to the growing openness of the Chinese economy. Many foreign technology companies such as Motorola, IBM or Microsoft, preferred to set up R&D centres directly in China, to enjoy the benefits of close proximity to their production bases and markets and the extensive support offered by central and regional government in their science parks. Although some people commented that most of the so-called 'science parks' in China were simply disguised low cost manufacturing bases for foreign companies, with no concern for clustering or synergy effects, the potential of some large scale science parks, such as 'ZhongGuanCun'[74] in Beijing, should not be overlooked. As one interviewee, who is from an ICT testing company, said:

> *'Even the big companies are more interested in investing in China than in Hong Kong. They will only set up a headquarters in Hong Kong to control the production lines in China. Because of the high cost structure of Hong Kong, most of their facilities are in China. Although the Hong Kong Government wants to help develop the IT industry…they are powerless to do so…'*

**5.3.3 Lessons and challenges ahead for the technology cluster**

**1. The importance of timing and the economic environment**

The constituency building process of the Hong Kong technology cluster was badly timed. Although the Hong Kong Government wanted to catch up in the late 1990s, they were unable to foresee the upcoming global economic and ICT downturn and the outbreak of the SARS crisis. One can say that Hong Kong was unlucky in this regard, but it also shows that 'timing' is a crucial factor in cluster building. While it is impossible to fully control the economic environment, leaving everything to luck is also unwise. Therefore, it is better to start the constituency process as quickly as possible at the right time, so as to obtain all possible advantages from an early start.

Equally important is a stable economic environment. Companies will be more reluctant to invest in innovation and technology development activities in an economic downturn. Therefore, the Government should have some flexibility in their cluster policies. Although

[74] Set up in 1988, and covering 1000 sq km, ZhongGuanCun is China's first large-scale high tech park. Inside the park, there are about 6,000 hi-tech companies and 400,000 highly skilled workers. Given its proximity to Tsinghua and Peking Universities, and well known research institutions such as the Chinese Academy of Science, the park successfully attracts huge numbers of technology companies, both MNCs and local ones, to agglomerate in the park. The park also organises large scale incubation programmes to support technology start ups. In 2000, the technological, trade and industrial revenue of the park was US$14 billion, contributing 60% of Beijing's industrial growth that year. (ZhongGuanCun Science Park, 2007)

most cluster policies are designed for a buoyant economy, if the economic falters, the Government has to adjust the content of their policies so as to meet the need of the stakeholders during that time.

**2. The importance of critical mass**

Hong Kong did not have a critical mass of ICT companies which could form a knowledge based ‘cluster’ and deliver synergy effects. Though some interviewees claimed that when a ‘critical mass’ of companies is present, they will start networking with each other and form a cluster without government intervention. Before the industry can achieve this ‘critical mass’ the Government can help by stimulating technological entrepreneurship, attracting technological inward investment to Hong Kong, encouraging more university spin-outs and company spin-offs. Besides, the Government has to maintain a favourable business environment and provide appropriate infrastructures, as well as financial and other soft side support.

**3. Define a specific and measurable goal and strategy**

The Hong Kong Government had a very ‘grand’ vision of becoming the innovation centre of China and Asia. However, this ‘vision’ has led to a number of problems in the constituency building process of the technology cluster. First, the Government’s vision did not match with the existing technological capability of Hong Kong’s technology companies. It was too ambitious and no surprise that a self-defeating mentality was prevalent in Hong Kong. Secondly, neither a specific target nor a measurable goal has been set for this vision and there is no timetable to inform the stakeholders when this vision will be realised. Therefore, the stakeholders did not know what the Government wants to achieve at the end. It was also difficult for them to give support to the government, because they did not know what to do.

A vision can be seen as the ‘destination’ of the cluster building process, while measurable goals can act as a milestone for the stakeholders, enabling them to check and make sure the constituency building process is on the right track. If the constituency building process is going well and the measurable goals are achieved, it will become an incentive to motivate and encourage the stakeholders to keep giving their support to the technology cluster until it achieves its aims.

### 4. Improving communication between the Government and stakeholders

#### a. Educate the stakeholders about the concepts of 'clusters'

As shown in the previous section, it seemed that the stakeholders (and some members of the Government) did not understand the concept of 'cluster'. Many of them simply took the word 'cluster' as a synonym for 'Silicon Valley'. They did not understand the essential features of a cluster–which are networking, innovating and learning, knowledge flow and synergies. Also, they did not know how to build a cluster from the beginning. Many stakeholders, and even the Government, tended to think that cluster building meant constructing infrastructure and setting up several institutions, such as a science park, research institutes, and providing some funding. They thought that this was all Hong Kong needed for a cluster! They did not understand that these institutions were just the beginning of the constituency building process. Interestingly, many stakeholders did not recognise that they were actually involved in this constituency building process. They also did not know that they had to change their old perceptions and behaviour, and start innovating and networking with other stakeholders. Therefore, there was a role for the Government, the leader and the initiator of the technology cluster, to educate and communicate with the stakeholders about the 'concepts' of the clusters and explain the appropriate way to behave in a cluster.

#### b. Enhance communication and trust between the Government and stakeholders

The poor communication between the Government and the stakeholders also led to distrust between the two parties. On one hand, the stakeholders, due to their misunderstanding of the cluster initiatives, believed that the Government did not want to help the industry wholeheartedly. On the other hand, the Government distrusted the stakeholders and, consequently, adopted a tight control over all the programmes and did not allow the stakeholders to have any flexibility. In fact, this problem of distrust could be solved through two way communication. Besides, trade associations can also play a role as an effective interface to facilitate the communication between the two parties. After all, communications could help align the Government's goal with the stakeholders' goal, perception and actions. In addition, as the Hong Kong case showed, when problems happened to the technology cluster, communication between the two sides, through government surveys and consultation, could help identify the shortcomings of the programmes, which could effectively assist the Government to design improved programmes to better meet the needs of the cluster stakeholders.

**5. Improve the technological capabilities**

**a. Developing technological capabilities in government and industry**

The constituency building process of a technology cluster in Hong Kong was hampered by the low technology capabilities of the Government, as the industry thought that the Government did not have the credibility to lead them in the cluster building process. Also, without sufficient technology capabilities, it would be less likely that the Government would design industrial policies which could meet the needs of the industry. Technology policies were long term policies in which experience and learning were crucial for its success. Although the Hong Kong Government could employ external consultants to conduct research for them, it was no substitute for the development of technological capabilities inside the Government. The setting up of the Innovation and Technology Commission in 2000 and the appointment of technology advisors in the Government helped improve the Government's technology capabilities and were beneficial to the constituency building of technology cluster.

As said, the ultimate aim of a cluster strategy was to develop technological capabilities of the industry. Although the overall technological capabilities of Hong Kong's companies were low, it did not mean that Hong Kong could not develop a technology cluster, even if the process would be more difficult. To upgrade the technological capabilities was a responsibility shared by all stakeholders of the technology cluster. While the government could assist the process by providing infrastructure and soft side support, it was not a substitute for the technology companies upgrading the technological capabilities themselves. The enhancement of the technology capabilities of Hong Kong companies should start with a change of attitude or mentality. They should feel that they need technology and want to change their old behaviour. This mindset change is a crucial initial step for ICT companies to start learning, innovating and networking in the cluster.

**b. Maintaining a long term commitment from the government and the industry**

Almost every successful technology cluster in the world takes time and effort to develop their unique and sophisticated technological capabilities because technology development is a path dependent process.[75] It is naïve to assume that Hong Kong can develop its technological

[75] Taking Taiwan as an example, it began to develop its Hsinchu Science Park, focussing on the IC industry, in the early 1970s. At an early stage of development, the operations incurred a huge loss, but with the steadfast assistance from their Government, for 20 years the Park has developed into a world-leading IC industry, including two of the world's largest IC fabrication plants, namely the United

capabilities to become a global competitive 'innovation centre' within a few years. Therefore, both the Government and the stakeholders have to take a realistic and long-term view. Unfortunately, the inability of technology development to solve the economic problems forced the Hong Kong Government to shift its direction to support the service sectors. This makes many people think that the Government has forfeited its 'hi-tech vision'. In this case the Government has to reiterate its long-term commitment to support technology development by designing long term technology policies and providing long term financial support.

The cluster stakeholders should also commit themselves to long-term innovation activities, ensuring that the constituency building process of the technology cluster can operate on a sustainable and long-term basis. However, the biggest problem faced by the innovation process in Hong Kong was the prevalence of a 'short-termism' attitude among companies. To bring about a change in attitude, the Government might let the stakeholders know the 'appropriate' attitude for technological development through its active promotion, and through setting an example by giving itself a long-term commitment to support industrial innovation and technology development.

**6. Improving the execution of the programmes**

**a. Emphasis on market led over technology push approach**

As many interviewees pointed out, the Hong Kong's constituency building process of a technology cluster tended to focus on the 'technology push' approach. The Government encouraged the industry to cooperate with the universities to conduct research and fund technology projects proposed by the universities. Due to the gap between universities' pure research and the industry's applied research, this kind of industry-university network rarely produced results which were commercially viable. In view of this, in the re-alignment programme which took place in 2004, the Government put much emphasis on the importance of 'market relevance' and 'industry participation'. This 'market led' approach was of particular importance to the ICT industry of Hong Kong focussing on consumer electronics and electronic components, such as IC design.

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Microelectronics Corporation (UMC) and the Taiwan Semiconductor Manufacturing Company (TSMC). The case of Taiwan shows that a long term vision is crucial for technology development.

**b. Emphasis on discriminative over inclusive approach**

At the early stage of the constituency building process, the Government did not define clearly which technology areas they wanted to develop. The definition of technology was so broad that the stakeholders of the technology cluster did not know which direction the Government intended to pursue. It seemed that a discriminative and focused approach would bring a higher chance of success in technology development, especially when the available resources are limited and a region only has very few industries that have a competitive advantage for a cluster to build on. A discriminative approach tended to be the best way to optimise the usage of the resources for the development of a cluster.

**c. Remove bureaucracy and improve efficiency**

The implementation of the constituency building process of the Hong Kong technology cluster was affected by Government's bureaucracy and red tape. To overcome the problem of bureaucracy, the Government set up a new organisation and streamlined the old organisations to enhance efficiency. For example, the Hong Kong Government set up a new organisation, the Innovation and Technology Commission (ITC), instead of giving the responsibility of technology development to the original Industry Department. The Government also consolidated the operations of Industrial Estates, Technology Centres and Science Parks into one organisation—the Hong Kong Science and Technology Park Corporation (HKSTP). While these new organisations were backed with resources and a commitment of support from the Government, they were free from the old mentality and bureaucracies. Besides, to remove the red tape the Government tried to simplify the vetting procedures of some of these programmes. For example, to apply for the Small Enterprise Research Assistance Programme (SERAP), applicants were just required to submit a one-page proposal and the responsible government department would notify the applicant about the results in a few weeks. The cooperation between the Government and industry could be improved due to the enhanced confidence and trust in each other.

**d. Pay attention to incentives**

The case of Hong Kong also showed that giving incentives was crucial to motivate companies to modify their mode of behaviour. Although the 'non-intervention' tradition of Hong Kong inhibited the Government from investing directly in companies, the Government might consider introducing 'less direct' incentive programmes. In some countries, like Japan and Taiwan, their governments would offer tax benefits to particular types of industry, like IC design, or R&D for telecommunication technologies. Singapore would offer tax deductions for companies' R&D programmes and China would offer free tax to technology management personnel with the aim of encouraging more people to enter the technology industry. The Government of Hong Kong may make reference to other countries' technology policies such as those mentioned above, so as to design an incentive policy which would best suit the special needs of Hong Kong.

**7. Focussing on cooperation with China**

The geographical enlargement of Hong Kong's technology cluster, in particular its integration with China in the Pearl River Delta area, became an important aspect of the constituency building process. Apart from their supplier networks in China, ICT companies should pay attention to deepening and broadening their networks to involve a knowledge aspect, to acquire technologies from the mainland through cooperating with leading research organisations and companies. Besides, the Chinese government has begun to encourage mainland companies to use Hong Kong as a platform to develop overseas markets. This provides good opportunities for Hong Kong to enlarge its technology cluster to include more resources and social constituents from China, including Mainland technology companies and research talents. To enhance Hong Kong's competitiveness, the Government and companies of Hong Kong need to abandon their parochial mentality, to open up themselves to absorb more resources from China and integrate in the larger technology cluster of the Pearl River Delta. The Government of Hong Kong may assist cluster stakeholders to establish and maintain networks with other clusters in China, so as to capitalise on the increasing opportunities in the world's largest emerging technology market.

## 5.4 Chapter summary

This chapter has illustrated the constituency-building process of the Hong Kong technology cluster led by the Hong Kong Government. The analysis of the process was divided into two levels, namely the regional level and the cluster level. These two levels are interconnected and mutually develop.

Section 5.1 introduced the structural environment for the rise and development of the technology cluster with the NSI/IC framework. The contextual analysis showed that Hong Kong possessed weak technical and social constituents for the technology cluster to build on. The structural characteristics of Hong Kong's environment included: 1) weak factor conditions due to a small industry base, dominated by SMEs and OEM manufacturers who were lacking the financial and technological capabilities necessary to innovate; 2) weak demand conditions since the local market was small and small ICT companies had difficulties in developing overseas markets 3) weak industry-university linkages due to the existence of cultural barriers on both sides 4) weak inter-firm relations due to a lack of complementarities and the absence of integrated local production chains. The weak contextual factors implied that the constituency building process of the Hong Kong ICT cluster would be a difficult one, with a lot of effort required to overcome the contextual weaknesses.

Section 2 gave an overview of the constituency building process of the Hong Kong ICT cluster for the last ten years. The analysis was divided into four phases, namely birth, growth, development and evolution. The first phase traced the origin of the ICT cluster shortly before 1997 when the first Chief Executive decided to build Hong Kong's economic future through encouraging innovation and technology development. This marked the beginning of the large scale constituency building process of the ICT cluster. Phase two described the Government's effort to build an ICT cluster, starting from its vision and strategy-setting through to the policy programme development. Phase three gave an account of the processes through which the Government fully launched the policy programmes to develop an ICT cluster. Phase four described the situation when Hong Kong underwent a deep economic downturn, partly due to the unexpected event of 9/11 and the outbreak of SARS. The Government urgently sought immediate solutions to the economic problems and decided to shift direction to support the service industries. In the meantime, the Government conducted evaluation and launched re-alignment programmes which emphasised a focused market and industry-led approach to solve the problems involved in the cluster building programmes.

Although the ICT cluster of Hong Kong has not achieved the level of success expected, the constituency building programme of the Government has successfully increased the financial and human resources available for technology development. The problems in the constituency building process of the Hong Kong ICT cluster were caused by the unfavourable timing and mis-alignments with Hong Kong's industrial and technology environment. The cluster also encountered some governance problems such as the Government's failure to communicate the vision and goals to stakeholders, and to provide sufficient support and incentives to motivate stakeholders to take part. The cluster stakeholders' ignorance of the cluster's vision and objectives and their distrust of the Government also hampered the implementation of the cluster policies.

# Chapter 6 Comparative Discussion of the data

**Objective: To compare the constituency building processes of the ICT clusters in Scotland and Hong Kong, with the aim of identifying their similarities and differences whilst drawing out common good practices for cluster building in different regions.**



## 6. Introduction

This chapter compares the similarities and differences of the constituency building processes of the ICT clusters in Scotland and Hong Kong, with the aim to shed light on some of the common good practices for cluster building and also provide useful lessons for others. This chapter mainly focuses on the comparison of the two clusters at the 'meso' level, while the similarities and differences of the two clusters at the macro level are outlined in Appendix 7. The structure of this chapter is as follows: Section 6.1 draws out the similarities of the constituency building processes of the ICT clusters in the two regions. Section 6.2 seeks to identify the differences of the two clusters at their cluster levels. Section 6.3 summarises ten steps in the process of building a technology cluster. Based on the lessons learnt from the

Scottish and Hong Kong cases, a number of 'good practices' of building a technology cluster are outlined, some issues about the public governance of a technology cluster are discussed. Section 6.4 compares the research findings with the literature and finally Section 6.5 gives a brief summary for this Chapter.

## 6.1 Similarities between the two ICT clusters in the two regions

The clusters in Scotland and Hong Kong shared a number of similarities at the regional and cluster levels. At the regional level, both clusters showed structural weaknesses in their industrial and technology environments which constrained the initial conditions for their cluster development. (see Appendix 7 for the full discussion of the similarities of the two clusters at their 'macro level'). Below is the comparative analysis of the two clusters at 'meso' level.

### 6.1.1 Cluster ('Meso') Level—Similarities between the constituency building processes of the ICT clusters in the two regions

#### i) Origins of the ICT clusters in the two regions

The ICT clusters in Scotland and Hong Kong are both driven by 'problems'. Scotland's ICT industry has been facing difficulties since MNCs in Scotland began to move to other low cost economies. Similarly, the OEM based ICT manufacturing industries of Hong Kong have been facing intensified competition from other low cost economies. To solve their problems, the governments of Scotland and Hong Kong sought the advice of highly regarded international consultants. Scotland appointed Michael Porter's Monitor Company to conduct research to its ICT sector and their report suggested Scotland should upgrade the industry's innovation level to produce high value added ICT products by developing a knowledge-based ICT cluster. In Hong Kong, the Government sponsored a research team from MIT to study the general industrial environment of Hong Kong, and the report of their study recommended Hong Kong to enhance the innovation level of the industries and upgrading them into knowledge-intensive ones by creating a macro-environment similar to a national/regional innovation system. Besides, the Asian Financial crisis and the burst of the stock and property bubbles in 1997 compelled the Government of Hong Kong to seek a quick solution for its economic problems by regenerating the local economies.

**ii) Common constituency building processes of the ICT clusters in the two regions**

The processes which the governments of Scotland and Hong Kong went through to develop their ICT clusters also shared a number of similarities as follows:

**a). Beginning with a mapping exercise**

The two regions began their constituency building processes with a comprehensive mapping exercise of their specific technology environment. For the case of Scotland, the Government mapped the 'ingredients' of the Scottish ICT cluster, such as key players, supporting institutions, infrastructures and markets. Like Scotland, Hong Kong also carried out a mapping exercise to assess its general technology environment. In contrast to Scotland, whose mapping exercise was based on technology sectors, Hong Kong's was geographically based. The mapping exercise helped enhance the understanding of the strengths and weaknesses of the industrial sectors and identify what was missing from the cluster. With the insights drawn from the mapping exercise, the two governments could identify the 'market failures' and design proper policies to help compensate for those 'failures', as well as to strengthening the weak 'ingredients' or 'links' in their respective clusters.

**b). Setting visions and drawing out of strategies**

After the idea of creating ICT clusters had obtained official approval in the two regions, the governments of Scotland and Hong Kong set the visions for their respective clusters and formally announced them to the public. Scotland's vision was to become '*the world's most enlightened locations for the next generation of system and silicon designers, developers and manufacturers*', whilst Hong Kong's vision was to become '*an innovation centre for South China and the region*'. Obviously, Scotland's vision was focused on a particular technology/sector. Also, measurable targets have been set in accordance with the vision. The target of Scotland's ICT cluster was '*to ensure that there will be at least 14,500 people working in the microelectronic industry*, *among at least 5,000 in design and development, 5,000 in manufacturing and 4,500 in supporting industries'*. However, the vision of Hong Kong was quite general and no specific target has been set to act as a yardstick to measure the level of success of its cluster.

Following the setting of visions, the two governments drew out the main strategies for building their clusters. The strategies for the Scottish ICT cluster focused on the industry level, aiming at strengthening the various aspects along the ICT value chain, whilst the strategies for the Hong Kong technology cluster focused on the regional level, aiming at strengthening the various aspects of the regional innovation system. At the same time, the way to implement these strategies had also been identified. The action plan drawn by the Scottish Government was in greater detail than its counterpart in Hong Kong. About 70 specific actions have been identified for building the Scottish ICT cluster, compared with 22 to create Hong Kong's regional innovation system.

**c). Translation of strategy to cluster policies—the institutionalisation process**

In order to get the social actors to engage in the constituency building process, and to modify their modes of behaviour in accordance with the cluster strategies, the two regions translated the cluster strategies into a number of public policies and respective institutionalisation processes. First of all, Scotland and Hong Kong set up formal organisations to spearhead the constituency building process of their clusters. The Scottish Government established a Cluster Team within the Scottish Enterprise. The Cluster Team was led and supported by top officials at Scottish Enterprise, including its Chief Executive Crawford Beveridge. In Hong Kong, the Government set up the Innovation and Technology Commission (ITC) in 2000, a new organisation with responsibility for the technology policies in Hong Kong. The ITC was chaired by top government officials and won the support from Chee Hwa Tung, the Chief Executive of the SAR Government. It could be said that the institutionalisation process sought to improve the legitimacy and credibility of the constituency building processes as well as contributing to the 'habitualisation' of the social actors to the cluster building activities in the two regions, thus ultimately helping to modify their behaviour.

Another step of the institutional process involved the translation of cluster action plans into a number of policy programmes. In fact, the cases of Scotland and Hong Kong demonstrated a tendency towards the convergence of cluster policies in different places. According to Freeman and Soete (2000), the convergence of innovation policies was partly due to the universal quality of technology development, coupled with global competition, which forces countries to learn/copy policies from successful counterparts. The cluster policies implemented in Scotland and Hong Kong concentrated on five areas:

1. Support applied and mid-stream research in the public sector
2. Encourage industrial R&D, especially in SMEs and facilitate technological networks, mainly with universities
3. Financial support for technology entrepreneurship
4. Infrastructural investment for technology development, such as the construction of science parks
5. Training and recruitment of R&D personnel

The initiatives implemented in Scotland and their comparable initiatives carried out in Hong Kong are listed as below:

Table 6.1 Similar cluster policy initiatives carried out in Scotland and Hong Kong

| | **Scotland** | **Hong Kong** |
|---|---|---|
| **Support for applied and mid-stream research** | ISLI, ITI | ASTRI, R&DC |
| **Support for R&D and network building** | SMART, SPUR, SPUR$^{plus}$ SCORE, SCIS | ITF, ITSP, UICP, SERAP |
| **Financial support for technology entrepreneurship** | PCF, EF, IF, SCIF, BGF | ARF, GEM, Incu-Tech |
| **Infrastructural support for technology development** | ACa, ACe, VCX, MTC, SESC | HKSP, CP, IC, PC |
| **Training and recruitment of R&D personnel** | FTS | ATS, AMPS |

In fact the initiatives carried out in the two regions are very similar. For instance, Scotland's SMART and SPUR awards are comparable to Hong Kong's Innovation and Technology Fund (ITF) programme, both of which aim at providing financial support for industrial innovation programmes based on competition. The SCORE programme in Scotland is similar to Hong Kong's University-Industry Cooperation Programme (UICP). Their common objective is to encourage industry-university collaboration by providing funding to cooperative research projects. Since the industrial structures of both Scotland and Hong Kong are dominated by SMEs, the two regions specifically launched Small Company Innovation Scheme (SCIS) and Small Entrepreneur Research Assistance (SERAP) to support innovation of SMEs. Besides, Scottish Co-Investment Fund (SCIF) is like the Applied Research Fund (ARF). Both operate as a matching grant to provide venture capitals for technology start-ups. Creating an infrastructure is a common cluster initiative adopted by the two regions. Scotland has constructed the Alba Campus (ACa) whilst Hong Kong built its Science Park (SP) and Cyberport (CP). They all act as a focal point for attracting technology companies to agglomerate physically and to provide supporting infrastructures for them to share. Moreover, Scotland's Intermediary Technology Institute (ITI) and Hong Kong's R&D Centre (R&DC) are based on some common rationales and thus deserve special attention: 1) these two initiatives were launched as part of the re-alignment programme of the ICT clusters in the two regions. 2) the two initiatives emphasise market-driven and industry-led approaches, whilst technological opportunities are identified by industrial players based on the market demand, 3) the two initiatives focus on generic and pre-competitive technology which may generate benefits for a wider range of stakeholders, 4) the two initiatives have chosen very similar technology targets, for example, optoelectronics, microelectronic design and digital media, nanotechnology, as well as emphasising convergence amongst these ICT technologies.

**d). The 'Problematic' nature of the cluster building process**

Because many countries operate a short time-scale when drawing up their cluster strategies they seldom anticipate the difficulties that may occur during the constituency building processes. Yet, the cases of Scotland and Hong Kong demonstrate that problems and crisis are almost unavoidable, many of which are unexpected and cannot be anticipated by the government. The two regions have come across a number of problems of similar nature:

**1) Too slow in approving cluster building**

The two regions initiated the idea of building an ICT cluster in early 1990s, but both faced a long delay because they did not get official approval for the building of a large scale cluster until 1997. The delay in implementing the cluster strategies had a negative impact on the constituency building processes of the ICT clusters in the two regions. While the governments of Scotland and Hong Kong were still debating whether to construct a cluster or not, governments in many other countries had already devoted huge resources to building their own clusters. Countries like Taiwan, India, Singapore or China have made enormous efforts to attract MNCs to their own countries. Once ICT companies have established their operations in one place, there would be an 'irreversibility' or 'lock-in' effect, due to their investments in factory buildings, equipments or training of staff, and therefore it would not be easy for them to move to another cluster. As a result, late-starters, like Scotland and Hong Kong, have faced great difficulties in getting ICT companies to locate in their clusters without being offered very attractive conditions.

**2) Resistance to change**

Scotland's biggest problem was the public's resistance to change. Opponents criticised the Government for favouring high technology industries at the expense of traditional industries. The fear of job losses also provoked an 'anti-cluster' climate and forced the Scottish Government to re-define its goals as the creation of a company to provide new jobs quickly, rather than pursuing innovation and technology development. Looking at Hong Kong, the cluster strategy also received much criticism from the public, first from the services sector and then from the property developers. In particular the former group disagreed with the Government's technology vision from the outset and they supported the Government when it changed its policy towards developing the service sector. These two examples show the necessity of balancing the interests of different actors in the constituency building process of the technology cluster.

**3) Global industrial downturn and regional economic recession**

The two governments commenced their constituency building processes around the similar period and both suffered from the global ICT downturn after 2001 with its consequential economic recession in their respective regions. In Scotland, the sharp decrease in global demand for ICT products encouraged many inward investors to shed jobs or close their subsidiary plants. This resulted in a 70% fall in the output of ICT sector and a loss of about 10,000 ICT jobs within a few years. Likewise in Hong Kong, the global ICT downturn also reduced ICT exports by about 8-10%, whilst the number of ICT companies and ICT employees declined by about 10 to 20%. This setback of ICT industries led to at least three problems to the clusters in the two regions: First, during the economic downturn, ICT companies had difficulties in maintaining their profitability, not to mention re-investing their resources in R&D or innovation activities. Second, the industrial setbacks largely defeated the efforts of the cluster building processes. Instead of seeing a growth of the ICT sector, the sector was shrinking, and this made the public see the effort being invested in the cluster building process as wasteful. Third, the decline of the ICT industry and the economic recession led to public discontent, particularly amongst those who lost their jobs. These people opposed the constituency building process and also reinforced public resistance to change.

**4) Governments' weak role and departure of cluster champions**

Apart from the structural problems of the two regions, the unimpressive results of the cluster strategies are partly derived from the two governments' inability to manage their clusters properly. As the results of the interviews showed, one of the greatest obstacles to the cluster building process came from the government itself. In short, both governments have made the following common mistakes: first of all, the two governments have not given sufficient support to the clusters. Many interviewees claimed that the level of support from their respective governments was poor in comparison to other countries like Taiwan and Korea which were determined to create government-led clusters. In Scotland, the Government only had a limited budget for its cluster development and the budget cut also posed threats to the sustainability of a large number of cluster initiatives. Similarly, the investment of Hong Kong in its cluster development was largely behind its neighbouring countries and the Government did not give sufficient incentives to motivate ICT companies to take part in the cluster. As many other empirical cases showed, to induce a structural change a government has to engage in high level intervention activities, including the use of huge financial resources to modify its industrial structure and compensate for many 'market failures'. However, the governments of the two regions simply viewed themselves as facilitators and refused to consider any high level involvement in the clusters. This 'half-hearted' approach made it difficult for the two regions to compete with other clusters in the world.

Second, the weak approach of the two governments also led to the absence or perceived absence of 1) a focused policy direction, 2) a holistic strategy and 3) a long term commitment from the governments of the two regions, which resulted in lukewarm support to the cluster policies by the cluster stakeholders. At the beginning of the cluster building process, both governments were not very focused and attempted to build several clusters at the same time. This not only confused the public about the government's direction, but also diluted the impact of the government supporting initiatives. Besides, although the two governments have designed comprehensive policies based on their cluster strategies, most stakeholders were unable to perceive the cluster strategy in a coordinated way largely as a result of the ineffective communication with their cluster stakeholders about the vision of the clusters. The cluster stakeholders in Scotland saw a large number of initiatives which led them to perceive the government as solving problems in a piecemeal way. The Hong Kong cluster stakeholders were confused by the traditional non-intervention policies in Hong Kong and did not believe the Government could help them. Moreover, the cluster stakeholders in the two regions doubted the governments' long term commitment to cluster development. In Scotland, the stakeholders considered the cluster policies as driven by politicians' personal interests and as not capable of surviving a change of government. Whereas in Hong Kong, the prevalence of 'short-termism' in the Government has made the stakeholders believe that the cluster initiatives could not be sustained in the long term.

Thirdly, the issues of credibility and trust played a part in affecting the constituency building process of the clusters in the two regions. Both governments were believed to be incapable of leading the cluster building process and implementing a top-down cluster strategy. The Scottish cluster stakeholders lacked confidence on Scottish Enterprise's abilities due partly to the occasional negative news reports about the incidents of its mismanagement. They also thought that the Government did not understand the industry well enough. Meanwhile, the cluster stakeholders of Hong Kong doubted the technological competence of the Government. The scandal over the construction of the Cyberport and the mishandling of the government's budget and the SARS crisis also seriously undermined the credibility of the Hong Kong Government. Lack of trust from the cluster stakeholders, which was closely associated with the loss of credibility of the two governments, not only hindered the leading role of the two governments in the constituency building process of the ICT clusters, but also indirectly led to the resignation of Robert Crawford of Scottish Enterprise and Chee Hwa Tung of Hong Kong SAR Government. The loss of these two cluster champions put the long-term sustainability of the two clusters in further question.

**e). Mis-alignments in constituency building and the launching of re-aligning programmes**

The development of the clusters of Scotland and Hong Kong was hampered by a number of mis-alignments at their early stages. Fortunately, the governments of the two regions were able to carry out re-alignment programmes to tackle these problems so that the constituency building process could continue.

### 1) Mis-alignments caused by the 'technology push approach' in the two regions

Both governments adopted a 'technology push' approach to encourage technological development. They may have been encouraged to do so by the example of other countries who sponsored military related research in public sector research organisations to promote technological development. Also, since much industrial research is conducted with 'unitarian' purposes, that is, to achieve product differentiation, this makes it easier to justify using public money to sponsor research in public sector research organisations. (Freeman and Soete, 2000) In view of the absence of military and national security related research in Scotland and Hong Kong, as well as the presence of strong research bases at universities in the two regions, the governments of Scotland and Hong Kong decided to encourage technological development by supporting the commercialisation of university research and also encouraging collaboration between industry and universities. For instance, the Scottish Government launched the Proof of Concept Fund (PCF) and the Edinburgh Fellowship (EF) to assist the commercial use of academic research. Whilst in Hong Kong the Government initiated the University-Industry Collaboration Programme (UICP) and the Innovation and Technology Support Programme (ITSP), both of which were open to universities in Hong Kong. However, this 'technology push approach' did not necessarily generate significant economic benefits. Due to the mis-match between the nature and culture of university and industrial research, many problems arose from their cooperation and the results of the industry-university collaborative projects in the two regions were not very satisfactory.

Besides, there was also a mis-alignment between the 'technology push' approach and the nature and maturity of ICT industries in the two regions. Scotland's ICT industry focussed on the production of semiconductors and electronic products, whereas the ICT industry of Hong Kong concentrated on the OEM production of consumer electronic products and electronic components. Both ICT sectors were based on relatively mature ICT technologies and their innovation activities were mainly driven by 'market pull' and incremental technology development. This explained why the two governments' 'technology push' approach could not meet the industries' needs as downstream innovation activities, such as applied research and product development, were more important to them. Their interactive learning processes also tended to orient towards customers and suppliers instead of public sector research organisations. Moreover, the cluster policies of Scotland and Hong Kong over-estimated the importance of R&D, while neglecting other activities, which were equally vital for successful innovation, such as sales and marketing.

In fact, the importance of meeting market demand had long been highlighted by Project SAPPHO which proved that a neglect of market demand was a major cause of failure in innovation (Freeman, 1991). Therefore, during the re-alignment programmes, the two governments endeavoured to integrate both 'technology push' and 'market pull' approaches to their 'reformed' cluster policies. This new approach can be seen in the operation of the new initiatives, Intermediary Technology Institutes (ITIs) in Scotland and R&D Centres (R&DCs) in Hong Kong. These two new initiatives support applied/mid stream R&D in a few target technologies based upon the technology foresight exercises drawn by the joint efforts of industrial experts. Universities or research organisations with specialities in the identified technological areas can conduct research or form consortia with industrial members to tackle the technological issues. This helps ensure that the technologies developed through these initiatives can better meet the market demand, thus enhancing the chance of success of the technology development in the two regions. Besides, the two governments also seek to help companies to develop complementary skills which are beneficial to the commercialisation of technology, such as marketing and technology management. For example, the governments of the two regions launched programmes to assist ICT companies to develop e-business and export channels in overseas markets.

**2) Mis-alignments caused by the 'top down approach' in the two regions**

The two governments commenced their constituency building processes mainly based on a 'top down' approach. Unfortunately, this approach has triggered many problems in the constituency building process. First, the idea of creating clusters was initiated by the top government officials of the two regions. The goals and perceptions of many stakeholders of the clusters might not be the same as the two governments as they did not request a cluster at the outset. For this reason, the two governments had to encourage those involved in the clusters to change their perception of the cluster building process through persuasion and motivation. Second, the cluster strategies and action plans were mainly formulated by the governments of the two regions, with the assistance from a small group of cluster stakeholders. Here the governments had to communicate and disseminate the cluster strategies and action plans to the wider cluster stakeholders. However, the two cases showed that communication between the two governments and their cluster stakeholders were fraught with difficulties. For example, the majority stakeholders were ignorant of the cluster plan, nor did they understand what was involved in a 'cluster'. Moreover, the two cases revealed that one of the communication problems was caused by the use of the term 'cluster'. Since the concepts and meanings of 'cluster' were quite new and not easy for the cluster stakeholders to understand, they found it difficult to identify as part of the technology cluster and this unintentionally inhibited the effective promotion of the technology policies in the two regions. The cluster stakeholders in Scotland were even hostile to the idea of cluster creation, as they associated it with the Government's 'winner picking' approach. Third, the two governments' 'top down' cluster strategy faced problems in transforming the mode of behaviour of the cluster stakeholders. On one hand, the governments of the two regions overlooked the diversity of interests of different actors in the cluster. For example, the government's vision of advancing to a 'knowledge-based economy' failed to appeal to the ICT companies as many of them did not see any immediate benefit to be gained from the cluster strategy. Besides, the interest of universities in knowledge advancement is different to the concern with profits in industry, so that the incentive programme provided by the governments may be attractive to industry but not to universities. Similarly, the two governments' intention to support new technology start ups may not be shared by many venture capitalists in the two regions as they preferred to invest in relatively mature and lower risk ventures. Also, young people in the two regions might prefer the financial advantages and job security available in finance and banking, rather than taking risks with technology companies.

Therefore, in the re-alignment programmes, the governments of the two regions tried to introduce a combined 'top down' and 'bottom up' approach. Breaking with past practice, the two governments invited the wider cluster community to take part in designing the 'renewed' cluster strategies. The 'new' cluster plans were circulated among the wider cluster communities and they were invited to comment. The governments also invited the industries members to take the lead in a number of new initiatives. For example, the Intermediary Technology Institutes (ITIs) of Scotland and R&D Centres (R&DCs) of Hong Kong were launched based on the assumption that industries have an advantage over governments and universities in identifying technological opportunities and developing technology. Besides, the governments of the two regions also paid more attention to balancing the different interests in the cluster. For example, the Hong Kong Government established priorities among various cluster stakeholders and gave funding priority to those industries involved in conducting R&D since the Government believed that its cluster should be rooted in the industries. In Scotland, the Government also tried to meet the interests of a wide range of stakeholders by compensating for the deficiencies in the innovation pipeline wherever it was required. For example, when venture capitalists hesitated about investing in Scottish technology start ups, the Government tried to boost their interest in indigenous technology ventures by setting up the Co-Investment Fund (CIF) to provide a matching grant to supplement their investment.

**iii) Similar level of success of the two ICT clusters**

The two regions also achieved similar level of success in their ICT clusters. In respect of the Scottish ICT cluster, even though the goal of enlarging the employment of the sector to 14,500, with 5,000 in design and development, by 2004 was not achieved, the cluster still had some positive results. The Scottish cluster strategy helped improve the technological capabilities of the ICT sector in the region in the following aspects:

- Improved institutional infrastructure for the ICT sector, such as Alba Centre, Scottish Microelectronic Centre, and Optocap.
- Increased financial resources for technology ventures: SMART, SPUR, SPUR$^{plus}$ funded £48.7 million (1999-2006) for 440 projects (Scottish Executive, 2007), Proof of Concept (POC) funded over £30 million for 184 projects (1999-2006). (Scottish Enterprise, 2007) About £5.7 million of the POC (1999-2004) went to ICT companies. (Scottish Enterprise , 2004)
- Increased R&D intensity of the ICT companies: higher ratio of staff engaging in R&D (10.2% overall and 15.5% for SMEs) and higher spending of turnover on R&D (5.1% overall and 8.3% for SMEs) (Scottish Enterprise, 2004)
- Attracted R&D talents worldwide. The number of ICT designers was nearly 2,000 in 2004, representing an increase of nearly two-thirds in five years (Scottish Enterprise, 2004)
- Closer relationship between industries and universities; intensified commercialisation activities; 33 university-spin-outs have been created through the support of POC since 1999. (Scottish Enterprise, 2007) 380 principal academics, 150 research groups and 14 technology transfer centres were dedicated to support the ICT sector (Scottish Enterprise, 2004)

Looking at Hong Kong, the Government announced the vision of making Hong Kong into an innovation centre of South China and the region in 1998. Even though by 2005, this vision has not been realised, the Hong Kong ICT cluster still managed to achieve the following results:

- Improved institutional infrastructures for the ICT sector, such as Hong Kong Science Park, Cyberport, IC Development Support Centre, and Photonic Centre.
- Increased financial resources for innovation activities, such as Innovation and Technology Fund (ITF) supported more than 500 projects (all sectors) at a total funding of £113 million (Innovation Technology Commission, 2004a)
- Increased R&D intensity business was reflected on the expenditure on R&D (BERD) to GDP, increasing from 0.12% in 1998 to 0.2% in 2002. It was estimated that about 1,223 establishments have undertaken R&D activities in 2002, compared with 887 establishments in 2001, representing an increase of 38%. Total expenditure on in-house R&D activities in the business sector amounted to £185.6 million in 2002.
- Increased human resources for innovation, compared with 1998, the total number of R&D personnel in 2002 increased by 43% to 12,890, with about 4,500 (35%) of them working for the business sector (all sectors).
- Improved relationships between industries and universities (through the University-Industry Collaboration Programme UICP) and also with research organisations in China (through the Guangdong and Hong Kong Technology Cooperation Funding Scheme G-HKTCFS)

The detailed comparison between the level of success of the Scottish and Hong Kong ICT cluster was difficult to accomplish as corresponding figures from the two regions were difficult to obtain. Scotland's statistics was more focused on the ICT sector, whilst the figures of Hong Kong produced a general picture based on all sectors and tended to generalise the overall situation of the region. Although the cluster visions of the two regions have not been met, the strategies did help generate similar results in the two regions, including strengthening the institutional infrastructures, finance and human resources available for technology development. The strategy also encouraged companies to increase their investment in R&D and fostered industry-university linkages. Scotland's cluster strategy has achieved better results in encouraging the development of university spin-outs, whilst the strategy in Hong Kong has succeeded in promoting technology linkages with China.

### iv). Evolution of the ICT cluster—Co-evolution, geographical enlargement, increasing specialisation

#### a) Co-evolution of clusters in stages

As the two case studies showed, the two clusters evolved over a number of stages, namely birth, growth, development and evolution. Each stage was dominated by a particular activity and new technical and social constituents were added and integrated into the constituency building process. For example, during the birth stage, a cluster champion appeared and sought wider support for the idea of cluster building, such as by commissioning a piece of credible research to convince others about its validity. At the next stage, cluster vision, strategy and policies had been designed, and more social constituents/actors were recruited to the cluster. At the development stage, cluster initiatives were launched, helping increase the momentum of the process. To increase growth new social constituents were added and new cluster initiatives were introduced. However, at this stage, some difficulties began to appear that inhibited the growth and further development of the cluster. At the evolution stage, the cluster champions assessed the progress of the cluster and introduced re-alignment programmes to solve some of the problems, to allow the cluster to continue to grow. At the end of this stage, new programmes were launched and new social constituents introduced. The structural characteristics of the cluster base tended to change with an increase in technology start-ups and an increase in R&D personnel. The geographical coverage of the clusters also tended to expand. All this showed how actors and structures were co-evolving together during the cluster building process.

Besides, the two case studies demonstrated that the number of cluster initiatives of the two regions increased over time. In Scotland the initiatives for supporting technology development have increased from one (Regional Selective Assistance) before 1993 to about 26 in 2005. Also, some flaws in the initiatives have been corrected, sometimes by introducing new initiatives. For example, in Scotland, the funding gaps along the commercialisation pipeline have been filled by introducing new funding schemes, such as Intermediary Technology Institutes (ITI), Industrial Fellowship (IF) and Co-Investment Fund (CIF). Similarly, in Hong Kong, the number of initiatives for encouraging technology development has increased from two in 1993 to about 31 in 2006. The new initiatives such as R&D Centres (R&DC) are also helping bridge the research gap between universities and industries by conducing mid-stream/applied research.

In addition to the increasing number of initiatives, the two cases also showed that the cluster strategies of the two regions have gradually integrated with the two governments' other strategies to form a holistic and comprehensive government policy. For example, the cluster strategy of Scotland gradually enlarged and integrated with the 'Smart, Successful Scotland' strategy which involved not only specific industrial sectors, but also a wide range of other issues, including internationalisation and learning. The two strategies complemented each other and helped Scotland to continue to advance towards a globally competitive knowledge-based region. In Hong Kong, the ICT cluster strategy also integrated with the larger 'Digital 21' strategy which was designated to develop Hong Kong into a competitive 'world city', harnessing its strengths in technology and digital development. The ICT cluster strategy is seeking to contribute to the objective by helping transform the ICT sector into knowledge intensive and valued added one.

**b) Geographical expansion**

Moreover, the two clusters exhibited a tendency of gradual geographical expansion, although the process was more obvious in Hong Kong than in Scotland. According to Porter's (1990) theory, a cluster can be sectoral or transnational. The case of Scotland's cluster building demonstrated the geographical extension process of the ICT sector. It started as a sectoral-regional (ICT-Scotland) innovation system and gradually extended its geographical boundary to become a sectoral-national (ICT-UK) or even sectoral-transnational (ICT-UK-Asia) system of innovation. As said, during the later stage of the ICT cluster, it was obvious that resources from Scotland were insufficient for the further growth of the cluster. Therefore, the social constituents of the cluster began to tap into nationwide resources. For example, ICT companies preferred to join national industrial organisations such as National Microelectronic Institute (NMI) and Joint Equipment and Materials Initiatives (JEMI). They sought listing on the Alternative Investment Market (AIM) and the London Stock Exchange to obtain investment capital. Some ICT companies also contracted their research to universities outside Scotland, such as to Bristol University or Cambridge University. Besides, some institutional resources for the Scottish ICT cluster (such as some equipment or facilities located in Alba Centre) were opened for users beyond the region. Furthermore, many ICT companies were eager to form technological partnership with overseas companies which located in the clusters of their respective countries or even set up subsidiary operations in these clusters, such as in China, Taiwan and Singapore. The Government also sought extra funding for the ICT cluster from international sources. For example, the Proof of Concept Fund (POC) received financial injection from the European Union. This reflected how the Scottish ICT cluster had grown from its sectoral-regional base to a sectoral-national or sectoral-transnational innovation system.

The geographical enlargement of Hong Kong's ICT cluster was more direct and noticeable. This was partly caused by the historical factor that many Hong Kong industrial companies have already moved to China since the late 1970s. The close networks which have long existed between the two regions facilitated this geographical enlargement process and the integration of resources between China and Hong Kong. The Hong Kong cluster was started as a regional innovation system. On one hand, the government gradually sharpened its focus to a sectoral/technological system (ICT). On the other hand, due mainly to the scarcity of resources (including land, human and technological) in Hong Kong, the cluster gradually brought in resources from outside (especially from Mainland China) and integrated them into Hong Kong's regional innovation system. Besides, the Government of Hong Kong took an active role in encouraging this integration. For example, the Hong Kong Government signed formal cooperative agreements with the Government of Guangzhou with the aim of taking advantage of the abundant resources in China. The Hong Kong Government also introduced an Admission of Mainland Professional Scheme (AMPS) to import talents from China, and proactively gave financial incentives through the Guangdong and Hong Kong Technology Cooperation Funding Scheme (G-HKTCFS) to encourage technological collaboration between the two regions. Many companies in Hong Kong acquired technology licenses from renowned universities in China, such as Tsinghua Universities, and contracted research to them. The geographical coverage of the cluster in Hong Kong has extended to the Pearl River Delta in the south of China and then gradually spread to some northern provinces in China (e.g. Shanghai, Beijing). The development of Hong Kong's ICT cluster can be regarded as an evolution from a regional innovation system to a sectoral-national and transnational innovation system.

**c) Increasing technological specialisation**

As well as the geographical extension of the two ICT clusters, there was also increasing technological specialisation in the two regions. At the early stage of the cluster development, both Scotland and Hong Kong lacked a focus and planned to build a number of clusters. The Government of Scotland has chosen the semiconductor, biotechnology, food and drink, oil and gas industries as the principal clusters and has planned to build more clusters around the optoelectronics, forestry, tourism, creative and software industries. Similarly in Hong Kong, the Government intended to make Hong Kong an innovative hub by developing a number of industries, including ICT, design and fashion, multimedia and entertainment, health food and pharmaceutics and professional services. The two governments were trying too many clusters which not only confused the stakeholders about the major directions of their policies, but also encouraged these clusters to compete with each other for the government's resources. As the two regions only have limited resource to build clusters, at the later stage, the two governments realised that they have to follow a 'focused' approach, and to choose a few technology areas in which the region has a real competitive advantage. Eventually, Scotland chose ICT (communication technology and media), energy and life sciences as the targets of its Intermediary Technology Institutes (ITIs), whilst Hong Kong decided to focus mainly on ICT and the related industries, and textiles and clothing[76]. This reflected a trend of increasing technological specialisation in the two regions. This phenomenon could also be explained by the fact that technology development had now become a global competition. To succeed a region has to choose a few areas and devote sustainable resources and effort to them to allow them to move ahead of their global competitors. Also, the universal nature of technologies[77] contributed to this trend of specialisation. The two regions have picked similar targets on optoelectronics, multimedia and nanotechnology, as they both recognised the technology opportunities emerging from these technology areas.

## 6.2 Differences between the ICT clusters in Scotland and Hong Kong

Given the differences in the historical, geographical and institutional background of the two regions, the two clusters exhibited differences in their constituency building and evolution processes. (See Appendix 7 for the full discussion of the differences between the two ICT clusters at the 'macro' level). The following comparison highlights the diversity of the constituency building processes in the two regions.

[76] The R&D Centres of Hong Kong focus on five technology areas, namely, ICT, automotive parts and accessory system, logistics and supply chain management enabling technologies, nanotechnology and advanced materials, and textile and clothing. Except for clothing and textile, four out of Hong Kong's five technology targets are related to ICT, so one can say that Hong Kong specialises on these two technologies.

[77] That refers to the fact that the generic characteristic/nature of ICT technology is the same regardless of geographical differences.

### 6.2.1 Cluster ('Meso') level—the differences between the constituency building processes of the ICT clusters in the two regions

**i) Market failure approach vs enhancing innovation possibilities**

Metcalfe (1994) identifies two approaches in technology policies, one which sees innovation possibilities for firms as given and one which seeks to enhance them. The former approach – the market failure approach attempts to reduce the cost of R&D in firms by offering R&D subsidies and tax incentives for R&D. The latter approach endeavours to enhance the innovation possibilities through encouraging collaborative R&D programmes among different firms and institutions. Although Scotland and Hong Kong's cluster building processes demonstrated an integration of these two main approaches, one could say that Scotland tended to focus on the market failure approach while Hong Kong paid more attention to stimulating innovation possibilities. Evidence shows that Scotland's early cluster initiatives such as POC, EF, SMART, SPUR mainly aimed at providing extra resources for innovation activities in industries or universities. None of these programmes emphasised or encouraged collaboration among different industrial actors or between industrial and academic actors. There was no incentive programme to facilitate the cooperation between industry and universities until recently. From the start of the Scottish ICT cluster little attention was paid to network building, with the result that networks between industries and universities were weak from the outset, so that both industry and universities tended to operate in isolation. In Hong Kong, the Government tended to follow the innovation possibility approach, which sought to encourage collaboration between different sectors, including industries and universities in Hong Kong and Mainland China. For example, the Government tried to foster industry-university partnership by offering financial incentives through the University-Industry Collaboration Programmes (UICP). In this programme, the Government subsidised industry-university networking activities at both research and student levels. Also, the Government encouraged the collaborative research activities between Hong Kong and Chinese organisations by offering funding for Mainland-Hong Kong Joint Research Projects. Fortunately, it seemed that the Scottish Government began to recognise the importance of networks at the later stage of its cluster building and in its re-alignment programmes. The Scottish Government started to launch the SCORE and SEEKIT programmes, which were similar to Hong Kong's UICP, seeking to provide financial support to industry-university partnerships, in particular with SMEs.

**ii). Different instruments used in the constituency building processes of the ICT clusters in the two regions**

**a) The instruments used by Scotland**

**1) The use of financial incentives**

One of the major differences between Scotland and Hong Kong's constituency building process was the use of financial incentives. Scotland has a tradition of offering financial incentives to attract MNCs to come to Scotland. Dating back to its 'growth point' and the 'sectoral approach', the Scottish Government has been offering Regional Development Grants or Development Area Grant to encourage companies to locate in the deprived areas of Scotland. Although the Regional Development Grant was abolished in 1988, today the Scottish Government still offers Regional Selective Assistance to companies to encourage them to create jobs in Scotland. Whilst in Hong Kong, offering financial incentives was against the traditional 'laissez-faire' approach. Therefore, when building its ICT cluster, the Government of Hong Kong only provided limited financial support to companies engaging in R&D activities and subsidised the rent of the Hong Kong Science Park and Cyberport to attract inward investors, but offered no large financial incentives. The Government of Hong Kong argued that the well developed infrastructures of Hong Kong, and its low tax policies, would be enough to attract technology companies from abroad to set up in Hong Kong.

**2) Attracting a flagship company/market leader to the cluster**

The Scottish Government also persuaded a market leader of the ICT industry to come to Scotland to start the cluster building process. Scottish Enterprise followed the example of Austin, Texas, where the government encouraged Micro-electronic and Computer Technology Corporation (MCC) to locate in the region by offering an attractive re-location package. Scottish Enterprise persuaded Cadence, a world leader in microelectronic design, to locate in Scotland by offering an attractive partnership package in the belief that the arrival of Cadence would help generate a virtuous cycle for the development of an ICT cluster in Scotland. They believed that Cadence would encourage its suppliers and customers to locate in Scotland, to spin out new technology start ups and create about 2,000 posts in microelectronic design. This could be regarded as a low-risk way to create a technology cluster. The arrival of the market leader could not only bring tangible benefits to the technology cluster, such as improving user-producer networks in the region and create employment opportunities (given they purchase and recruit locally), but it could also lead to intangible advantages, such as boosting the image of the technology cluster, which may in turn attract more technology companies and R&D talents to come to the region. The Government of Hong Kong has persuaded ICT giants such as Microsoft and Philips to locate in its science park. However, the Hong Kong Government did not expect them to kick start the agglomeration process of the ICT cluster. Instead, they simply hoped that their presence would improve the image of the Science Park and Cyberport, so that more technology companies and R&D personnel would be attracted to the region.

**3) The supply chain approach**

The Government of Scotland has also paid more attention to the supply chain approach in building its ICT cluster than Hong Kong. After realising the importance of user-producer networks in the flow of knowledge and interactive learning, whilst also recognising the Scottish ICT sector's weakness from not having an integrated local value chain, the Government tried to foster a network of this kind. For instance, the Government encouraged BAE Systems to develop a complete local production chain for its diode pumped solid state laser products, in which companies based in Scotland were responsible for product design, manufacturing, and the sale of the finished product. However, the Government of Hong Kong did not emphasise the supply chain approach. This could have been due to the fact that most ICT manufacturing companies in Hong Kong have already relocated to China and that there was almost no manufacturing plant left in Hong Kong. The Government of Hong Kong did encourage Hong Kong ICT companies to upgrade the technological capabilities of their suppliers in China.

**4) Growing an indigenous sector through supporting university-spin outs**

After the industrial setback and the massive retreat of inward investors from 2001 to 2003, the Government of Scotland realised that the 'inward investment approach' could not be sustained. Therefore, in the re-alignment programme of its ICT cluster, the Scottish Government changed its focus from the 'inward investment' approach to supporting indigenous companies, particularly university spin-outs which engaged with the microelectronic and optoelectronic industries. Scotland had a very robust research base at the universities and Scottish Enterprise specially designed initiatives, such as the Edinburgh

Fellowship (EF) and the Proof of Concept Fund (POF), to support company formation from universities. Since its inception in 1999, the POF has given £30 million to support the formation of 33 spinouts from universities. (Scottish Enterprise, 2007) These university-spin-outs had a high R&D intensity and technological capabilities. They also have maintained better relations with the universities and benefited from access to university equipment and expertise. On the other hand, the Government of Hong Kong did not emphasise the 'university spin-out' approach. This could be because Hong Kong's university research base was not as strong as Scotland's. Formation of companies from universities was a more recent phenomenon in Hong Kong. Except for a few, the survival and success rate of Hong Kong's university-spin outs was not particularly impressive. Another weakness of the university spin out approach was that it usually took a very long time to generate results, which did not fit in with the Hong Kong Government's aim of a quick solution for its economic problems.

**5) Creating interface mechanism**

Despite no financial incentive being given, the Government of Scotland was active in creating interface mechanisms to facilitate the networking of different social constituents in the ICT cluster. Due to the differences in the interests and the mode of operations of various social actors in the clusters, there were always difficulties in bringing them together and encouraging them to cooperate with each other. Therefore, the Government of Scotland specially supported a number of networking organisations, which acted as an interface to facilitate the cooperation of different social actors. In addition to the university technology transfer offices, which acted as an interface for universities and industries, other interface organisations supported by the Scottish Government included Local Investment Networking Companies (LINC), an organisation to facilitate the networking between angel investors and companies, CONNECT, a networking organisation which brought together venture capitalists and local start ups and Technology Venture Scotland (TVS), which promoted the cooperation between industries and universities at the policy level. However, the Government of Hong Kong seldom paid attention to creating interface organisations to improve the cooperation between different actors in the cluster. No organisations similar to the Scottish networking organisations were found in Hong Kong.

**b). The instruments used by Hong Kong**

**1) Encouraging informal networks**

The importance of informal networks in cluster building has been highlighted by the regional innovation system approach (Cooke, 1995). They are very closely related to the associative culture of a particular region so that governments find it very difficult to take the lead in creating them. Yet, it seems that the Hong Kong Government made better use of informal networks to create favourable market governance than the Government of Scotland did. The Scottish Government set up an informal organisation, namely the Scottish Electronic Forum (SEF) to bring together the ICT companies. However, it failed to achieve this aim as the small companies felt that they were crowded out by the big companies and this eventually led to the dissolution of the SEF. In contrast, Hong Kong's trade associations, such as the Federation of Hong Kong Industries and the Chinese Manufacturer's Association helped strengthen the informal networks in the ICT cluster. These trade associations not only lobbied the Government about ways to support the technology development of Hong Kong, but also cooperated with the Government in encouraging technological development among their members, thus creating favourable market governance for the Hong Kong ICT cluster. In Scotland, it seems that the Government only realised the importance of informal networks at the later stage of its cluster development. In the re-alignment programmes, the Government helped establish a number of new trade associations, such as Electronic Scotland (ES) for the electronic companies and the Scottish Optoelectronic Association (SOA) for the optoelectronic companies. The new organisations included both small and big companies and tried to balance the differences between them. SOA even had over 90% of the Scottish optoelectronic companies as its members. The popularity of these informal organisations also helped align the perceptions and goals of the social actors with the ICT cluster.

**2) Creating innovative milieu**

The Hong Kong Government also devoted efforts to nurturing an 'innovative milieu' through the implementation of the 'Digital 21 Strategy'. The Government generated a milieu which aligned with the goal of the ICT cluster from a 'bottom-up' perspective. Through the Digital 21 Strategy, the Government promoted the use of computer and communication technologies in the education and business sectors, and organised a variety of large-scale technology related exhibitions and international conferences to enhance the public's awareness and knowledge of ICT. This helped reinforce the favourable milieu and strengthen the positive market governance for the constituency building process of the Hong Kong ICT cluster. Yet in Scotland, the Government did not have any initiative to foster an innovative milieu of the region until recently. A new initiative to improve the innovative milieu was introduced in 2003, in association with the Smart, Successful Scotland Strategy. A High Technology Talent Board was set up to design a range of programmes to enhance school students' interest in science and technology.

**3) Government as a buyer of ICT products**

Mowery and Rosenberg (1993) attributed the success of the US's electronic industry to the role of the US Government, in particular the military as a major buyer of the ICT products. In Hong Kong, the Government also tried to support the local ICT market by increasing local procurement. For example, the Government outsourced IT projects valued at £55million to local ICT companies in 2000-2001. The Government also tried to stimulate the local software industry market by launching the e-government programmes, in which the Government employed local software companies to help put information about government departments and public services on-line. According to the Government data, about 95% of the government IT projects have been outsourced in 2006. On the contrary, in Scotland, the Government did not have any special programme to boost local procurement. Not much attention has been paid by the Government to its potential role as an influential buyer for the ICT industry.

**iii). Differences between the evolution of ICT clusters in the two regions[78]**

**a). Sectoral innovation system vs regional innovation system**

A number of cluster scholars have argued about the appropriate boundary for a cluster. For example, Lundvall (1992) argues that a national boundary still matters for an innovation system, whilst Nelson (1993) questions whether a national boundary is appropriate today and suggests a sectoral innovation system running across the boundaries of several countries as a better reflection of the current reality. Porter (1990a) proposed a 'flexible' boundary for a cluster, which can be within a region or spread across several countries. As the two cases

[78] The evolution in the geography dimension of the two clusters has been discussed in section 6.1.1

showed, the reality is actually quite complex and the boundary of a cluster may change over time. Since ICT has become a truly global industry (Peters, 2006) Scotland and Hong Kong's ICT clusters have spread over the boundaries of several countries. Interestingly the evolution of the two ICT clusters was headed in different directions. In short, Scotland's constituency building process began as a sectoral innovation system which its supporting cluster policy programmes, such as Alba Campus, Alba Centre, Institute of System Level Integration and Virtual Component Exchange, were developed around one specific sector. However, as the cluster evolved, it began to join other initiatives in the Smart, Successful Scotland initiatives to build a regional innovation system. On the contrary, the evolution process of the cluster of Hong Kong started as a regional innovation system without setting any specific technology focus. Several technology targets emerged, but were later reduced to a few. Initiatives for supporting specific industries began to emerge, such as the IC Development Centre and Photonic Centre at the Hong Kong Science Park. Therefore, the evolution of Hong Kong's cluster could be said to follow a path of a regional innovation system to a sectoral innovation system.

**b). Shift of goal vs shift of means**

The two clusters have come across a number of difficulties to which the two governments have responded differently. Despite facing a massive loss of inward investors during the ICT industrial setback from 2001 to 2003, the Government of Scotland demonstrated its long-term commitment to support the ICT industry by allocating £450 million to fund the Intermediary Technology Institutes (ITIs) for ten years, in which ICT was chosen as one of its three main technology targets. The Scottish Government also launched a number of re-alignment programmes in 2003 to help improve the operations of the ICT cluster in various aspects. Since 2003, 9 new initiatives have been launched to enhance the overall operations of the ICT cluster. However, the Hong Kong Government had a very different response to the region's problems. After the SARS crisis, and the associated economic downturn in the region, the Government of Hong Kong decided to shift its goal from pursuing industrial technology development to supporting the four pillar service industries, namely tourism, logistics, financial service and producer service industries. Even though the Government of Hong Kong has launched a number of re-alignment programmes for the ICT cluster in 2006, its programmes have only touched areas which were smaller both in size and number than their Scottish counterpart. Only three new initiatives have been introduced so far. This reflects the fact that Scotland has resolved the problem of the ICT cluster by changing some of its means, whilst Hong Kong has chosen to change its goals.

**iv). Different levels of alignment of the cluster building processes in the two regions**

The two clusters showed different levels of alignment at their final stages. It seemed that the Scottish cluster was better aligned in the various dimensions of its sociotechnical constituency than the cluster of Hong Kong. Table 6.2 compares the alignment conditions of the different dimensions of the ICT sociotechnical constituencies in 2006.

Table 6.2 Comparison of the alignment conditions of various dimensions of the sociotechnical constituencies of the ICT clusters in Scotland and Hong Kong by 2006

| |
|---|
| **(I) Constituents' perception, goals, actions and resources**<br>• The industrial players of the two regions were more aware of the importance of innovation and technology development after the introduction of the cluster strategy and the global ICT setback. The two regions showed an increase of R&D investment and more active participation in innovation activities. The perceptions of the social constituents in the two regions were more aligned with the goal of the two clusters.<br>• The Scottish Government re-defined the cluster's goal to make it closer to reality and decided to root the ICT cluster in the industrial sector. Instead, Hong Kong dropped the vision of becoming 'an innovation centre of Asia' and shifted to pursuing development in the service industries. Technology development lost its priority on the Government's agenda.<br>• The Government of the two regions initiated reviews on the ICT clusters and launched re-alignment programmes. New actions were launched to compensate for the weakness of the early cluster policies. Scotland's re-alignment programmes were more comprehensive as they addressed the deficits by introducing a market-led approach, filling funding gaps and streamlining operations. The re-alignment programme of Hong Kong simply focused on strengthening the mid-stream research capabilities of the ICT sector based on a market-led approach.<br>• Both Scotland and Hong Kong have improved their institutional infrastructure, finance and human resources after the implementation of the cluster strategies, although they were still facing problems such as the absence of a local industrial leader and weak inter-firm networks. In Scotland, however, the presence of Cadence partly responded to this need. In short, the ICT cluster in Scotland had better resources than the ICT cluster in Hong Kong. The reduction in the number of ICT companies and employees, due to the closure of MNC manufacturing plants, was compensated partly in Scotland by the growing number of university spin-outs, and MNC design centres with high R&D intensity and technological capabilities, but in Hong Kong the size and the structure of the ICT sector were more or |

less the same. This implies that the cluster strategy had greater impact on the structural characteristics of the ICT sector in Scotland than in Hong Kong. Besides, the research base of the high education sector in Scotland was stronger than that of Hong Kong, due to higher research funding and more active involvement in commercialisation and technology transfers.

- China was perceived as potentially the largest ICT market in the world and Hong Kong was in a stronger position than Scotland to capture this huge market due to its close relationship with China. Hong Kong also enjoyed first mover advantage in penetrating the China ICT market through its participation in China's technology development programme.

**(II) Nature and maturity of the technology**

- Despite the launch of the cluster strategy to improve the technology level of the ICT companies in the two regions, the majority of them still engaged with mature ICT technologies with little R&D. A high-tech ICT cluster has still to be developed in either region, but the problem was more serious in Hong Kong.
- The technology focuses of the ICT clusters, including microelectronic, optoelectronic and multi-media, were in line with the latest technology trend. The two regions were also prepared to exploit the emerging opportunities arising from the convergent trend of ICTs and new ICT sub-fields, such as nano-technology.

**Alignment (1) Governance**

- At the end of this stage the governance of the two ICT clusters was improved after the launch of the re-alignment programmes. The governments of the two regions adopted a focused approach and created mechanisms that reflected more attention to communicating with the cluster stakeholders.
- The governance of the Scottish ICT cluster seemed to be more advanced and stable than the ICT cluster of Hong Kong. The Scottish Government enhanced the governance of the cluster by setting up mechanism to evaluate its progress on a regular basis. Whilst in Hong Kong, the governance of the ICT cluster weakened after the departure of the two cluster champions. The new government chief did not favour technology development.[79]
- Informal/market governance was improved in the Scottish ICT cluster and ICT companies were more active in participating in the ICT trade associations. The market/informal governance of Hong Kong aligned favourably with the ICT cluster due to the promotion of the trade associations and the Digital 21 Strategy.

[79] The weakened governance of the Hong Kong ICT cluster was shown in the frequent change of CEOs of the HKSP and ASTRI after 2004 as well as the revelations of their financial mismanagement. The management were accused of misusing public money on entertainment and Fengshui consultations. (Ming Pao Daily News, 19 April, 2007; 17 May, 2007)

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| **Alignment (2) Nature of the Target problem**<br>• In spite of the governments' efforts the cluster strategies have not yet solved the target problems of the two regions, namely to upgrade their traditional, low value added, ICT manufacturing industries to innovative, high value added, ICT industries with strong design capabilities.<br>• The two regions were still troubled by problems such as low technology capabilities, weak user-producer networks, cultural barriers between industries and universities and low technology entrepreneurship. The problem in Hong Kong was more complicated, especially as the Government actually withdrew their commitment to technology development. Whereas in Scotland, the cluster strategy helped relieve some of the problems mentioned above. The Government of Scotland also demonstrated their commitment to supporting the technology development of its ICT sector in the long term. |
| **Alignment (3) Target constituents' perceptions and pursuits**<br>• The Government of Hong Kong has paid attention to the geographical enlargement of the ICT cluster. New measures were implemented to engage new social constituents, such as governments, ICT companies and VCs from abroad and China, to the ICT cluster. The perceptions of these target constituents were potentially aligned with the Hong Kong ICT cluster as they regarded Hong Kong as an ideal platform to penetrate China and to expand overseas.<br>• Whereas in Scotland the Government made little effort to facilitate the geographical enlargement of the ICT cluster. The Government tried to engage target constituents from other ICT sub-fields, such as those from micro, opto, tech com, as well as those from other science disciplines, such as biology, chemistry and physics. The perceptions of these target constituents were potentially aligned with the Scottish ICT cluster because they wished to pursue the opportunities arising from the convergence of different ICT technologies, such as multi-media, and new emerging technology such as nanotechnology. |
| **Alignment (4) Interacting technologies/constituencies**<br>• The competitors of the Scottish ICT cluster were mainly from the same region. The other initiatives of the Government diverted the financial resources available for the Scottish ICT cluster. The Scottish ICT cluster was facing budget cuts and shedding of members from the cluster team. There is also interaction with other technologies/clusters, such as biotechnology and life sciences.<br>• The competitors of the Hong Kong ICT cluster mainly came from China. On one hand, the ICT clusters in China directly competed with Hong Kong's ICT cluster for target constituents such as overseas technology companies. On the other hand, the Chinese clusters complemented the Hong Kong ICT cluster by supplying technology, human resources and a manufacturing base for Hong Kong. |

The following table summarises the context, content and process of the ICT clusters in Scotland and Hong Kong.

Table 6.3 Comparison of ICT clusters in Scotland and Hong Kong in their context, content and process

| | | **Scotland** | **Hong Kong** |
|---|---|---|---|
| **Context** | **Structural factors** | | |
| | -Economic background | Service sector dominant (>70%) | Service sector dominant (> 80%) |
| | -Historical factors | MNCs attracted by government grants | MNCs attracted by cheap labour |
| | -Industrial structure | SME dominant (98%), low R&D intensity (0.27%) | SME dominant (98%), low R&D intensity (0.3%) |
| | -Government policies | Interventionist | Laissez-faire/proactive enabling |
| | -Entrepreneurial culture | Low, risk aversive | High, short-termism |
| **Content of the cluster** | **Technical constituents** | | |
| | -nature of technology | Mixed with mature and emerging ICT technologies currently focussing on microelectronics, opto-electronics, telecommunications, e-commerce | Majority mature, production based ICT technology currently focussing on opto-electronics, microelectronics, telecommunication and e-commerce |
| | **Social constituents** | | |
| | -R&D talents/ firms' personnel | High quality and sufficient number | Lack of experience & insufficient number |
| | -technological capabilities | Dualistic, mixture with high and low | Majority low |
| | -institutional infrastructure | More institutions (SP, R&D centres, Tech support Ctr.) | Less institutional infrastructures (no SP until late 90s) |
| | -financial set up | Financial centre, but VC do not invest locally | Financial centre, but VC do not invest locally |
| | -local interfirm relationship (include competition) | Weak local user-producer networks, weak local competition | Weak user-producer networks, but strong supplier network in China, weak local competition |
| | -PSR knowledge base and relationship with industry | Strong PSR base, weak industry-PSR linkages | Less strong PSR base, weak industry-PSR linkages |
| | -informal relationships | Average | Good |

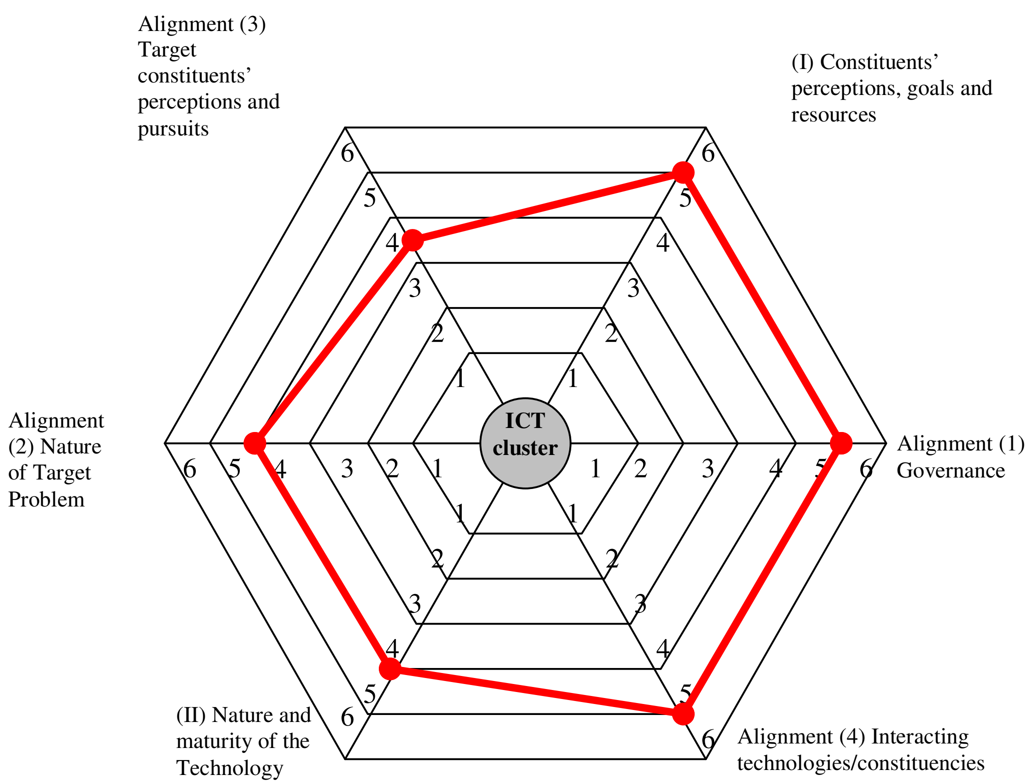
| | | | |
|---|---|---|---|
| | **Governance of the cluster** | | |
| | -origin | Government initiated cluster | Government initiated cluster |
| | -aims and objectives | Clearly defined but not recognised by stakeholders | Undefined and not recognised by stakeholders |
| | -strategy | Focused but not perceived by industry | Less focused and not perceived by industry |
| | -attraction and persuasion | Greater financial incentive for MNCs but insufficient incentive for industry-PSR linkages | No financial incentives for MNCs, but some financial incentive for industry-PSR linkages |
| | **Perceptions and pursuits of social constituents** | | |
| | -motivation | Weak motivation, cannot perceive benefits | Weak motivation, self-defeating mentality |
| | -involvement | Weak perception of involvement | Weak perception of involvement |
| | -roles and contributions | Weak perception of role and contribution | Weak perception of role and contribution |
| | -alliance building | Positive perception but limited alliances, lack of common commercial interests | Positive perception but limited alliances, lack of common commercial interests |
| | -technological collaboration | Positive but limited, lack of complementarities among actors | Positive but limited, lack of complementarities among actors |
| | -commercialisation of technology | Positive and growing commercialisation activities, universities are pro-active participants | Positive but limited commercialisation activities, universities are inactive participants |

| | | | |
|---|---|---|---|
| **Process** Alignment with STC dimension 1,2,3,4 | **Governance of the cluster (dimension 1)** | | |
| | -formal governance | At the beginning cluster faced a number of problems with surrounding governance, but now positively aligned after introducing the re-alignment programmes | Cluster faced a number of problems with the surrounding governance, improved slightly after introducing the re-alignment programmes |
| | | Strong policy alignment as government reinforced commitment towards technology development | Strong mis-alignment as government dropped the vision of technology development |
| | -informal governance | Market governance was mis-aligned at the beginning, but now become positively aligned after the industrial setback | Mis-alignment from the outset, now become strong mis-alignment as the market generally support the shift of government direction to promote services industry |
| | **Nature of target problem (dimension 2)** | Target problem was too ambitious and the following problems and advances can be noted: | Target problem was too ambitious and the following problems and advances can be noted: |
| | -missing 'ingredients' | Lack of critical mass, but now positively aligned as government encourage more new business development | Lack of critical mass, but now weakly mis-aligned as government has no plan to encourage new business development |
| | -success and failure | Increase institutional and financial resources | Increase institutional and financial resources |
| | | Enhanced technological capabilities | Little improvement in technological capabilities, |
| | | Improved industry-PSR linkages, | Little improvement in industry-PSR linkages |
| | | Improved technological entrepreneurship | Little improvement on technological entrepreneurship |
| | | Little improvement on overall industrial structure | Little improvement on overall industrial structure |
| | -survival and sustainability | Strong positive alignment as government has long term commitment | Strong mis-alignment as government decided to drop commitment |

| | | | |
|---|---|---|---|
| | **Target constituents' perception and pursuits (dimension 3)** | | |
| | -motivation | Potentially positive motivation due to emergence of new ICT technologies | Potentially positive motivation due to the attraction of China market |
| | -involvement | Potentially positive perception of involvement, require more incentives from government | Potentially positive perception of involvement, require more incentives from government |
| | -roles and contributions | Potentially positive perception of role and contribution, need more govt promotion | Potentially positive perception of role and contribution, need more govt promotion |
| | -alliance building | Potentially positive perception towards alliance building (e.g. supply chain approach) | Potentially positive perception towards alliance building (e.g. joint ventures between HK & China) |
| | -technological collaboration | Potentially positive perception towards technological collaboration (e.g. ICT & biotechnology) | Potentially positive perception towards technological collaboration (e.g. HK-China cooperation) |
| | -commercialisation of technology | Potentially positive perception towards commercialisation of technology (e.g. ITI) | Potentially positive perception towards commercialisation of technology (e.g. R&D Centres) |
| | **Interacting technologies/ constituencies (dimension 4)** | | |
| | -relation with other clusters | Positive alignment, increased interaction with other clusters | Positive alignment, geographical enlargement with clusters in China |
| | -interaction with other technology | Positive alignment, integrated with other ICT technologies, greater interaction with other technologies | Weak positive alignment, competition with other technologies but government decided to focus on ICT |

Figure 6.1 and 6.2 made use of Molina (2003)'s spider-web tool to illustrate visually in a summary fashion the alignment condition of the sociotechnical constituencies of ICT clusters of Scotland and Hong Kong by 2006. The assessment is not intended to be quantitatively exact or scientific. It is rather an approximate interpretation based on the qualitative information given in the chapter. Numbers on the spider-web represent the level of alignment as follows: ***No. 6: very strong alignment, No. 5: strong alignment, No. 4: weak alignment, No. 3: weak mis-alignment***[80]***, No. 2: strong mis-alignment, No. 1: very strong mis-alignment***. The red line illustrates the overall alignment condition of the Scottish/Hong Kong ICT cluster.

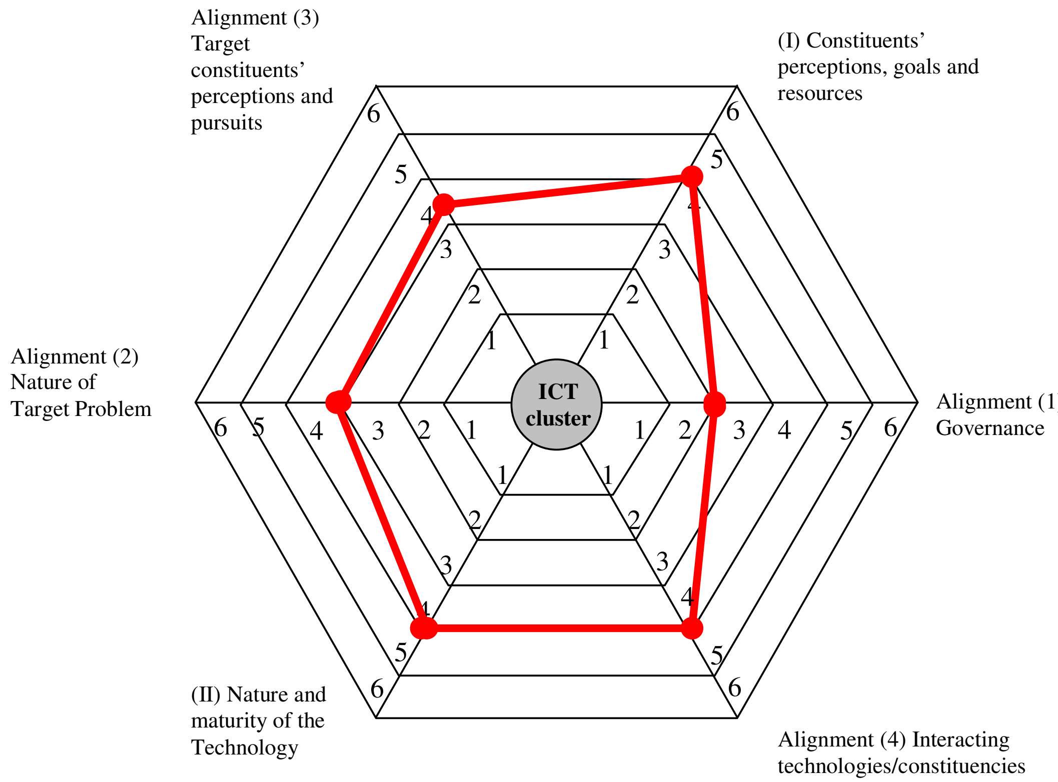
Figure 6.1 The spider-web graph depicts the alignment condition of the ICT cluster in Scotland




*Alignment dimension 3 – Target constituents' perceptions and pursuits, is given a mark between 3 and 4 because, being target constituents, there is no alignment yet although the potential is good.*

[80] Weak mis-alignment represents the situation that has a potential to be positively aligned again in future.

Figure 6.2 The spider-web graph depicts the alignment condition of the ICT cluster in Hong Kong




*Again, alignment dimension 3 – Target constituents' perceptions and pursuits, is given a mark between 3 and 4 because, being target constituents, there is no alignment yet although the potential is good.*

## 6.3 Common good practices for the cluster building process

### 6.3.1 Implications for the cluster building processes

#### i) The nature of cluster building

a. **Cluster building as a complex process**

Policy makers in the world tend to regard cluster building as a mean to 'reproduce' Silicon Valley in their countries. Yet, not many of them have a true understanding or realistic expectations about the cluster building process. The cases of Scotland and Hong Kong clearly demonstrated that cluster building is a highly complex process, which involves 1) multi-levels; 2) multi-domains, 3) multi-actors and 4) systemic innovation.

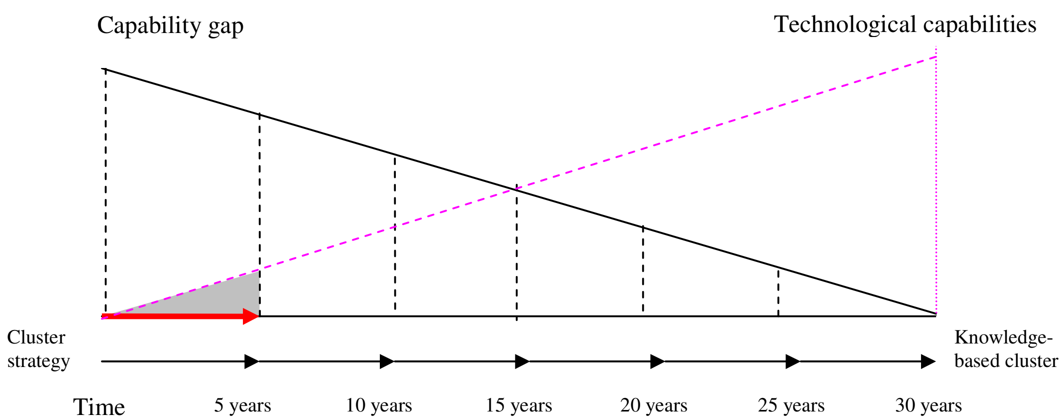
First, the three-level analysis, namely the 'micro' project level, 'meso' cluster level and 'macro' regional economy and ICT industry level (applied fully to the case of Scotland), help shed light on the multi-level nature of cluster building. The evolution of the three layers altogether constitutes the overall development process of the cluster and helps shape its direction. Therefore, government intervention on cluster policies should focus on all three levels. Second, the process of cluster building requires associated changes at a number of domains. A cluster does not only relate to technological change and institutional set up, but also to the transformation of the economic, industrial and technological environments of the region. The history, geography and culture also will play a part in this transformation. Third, a wider range of actors (social groups) including industries, government and academics are involved in the cluster building process. The psychology of these actors, including their perceptions and motivations are of relevance to the creation of the dynamics which help modulate the cluster building process. Besides, the government which fosters cluster development should also pay attention to a wider group of social actors who have the potential to become part of the cluster in future.

Lastly, cluster building is about transforming or creating a whole system for innovation. Thus, in addition to the building of infrastructures, other elements in an innovation system, such as user-producer networks, government policy support, financial sector, R&D capabilities of firms and research institutes, also play significant roles in the cluster building processes. Besides, an understanding of the systemic nature of cluster development means that a shift in one element is likely to affect the other elements in the cluster. This implies that a government who seeks to build a cluster should design a holistic policy and adopt a systemic perspective to manage the linkages among various components in the cluster.

### b. Cluster building as a long-term evolutionary process

The historical analysis of the two clusters in Scotland and Hong Kong showed that cluster building is not only an immediate event but also a time-based, long-term process involving different stages, namely the birth (initial recognition of opportunities or problems), growth (selection cluster strategy out of various options and design cluster policies), development (execution of cluster policies and momentum generation) and evolution (evaluation and re-alignment of policy programmes through continuous learning and innovation). The long term cluster building process is illustrated in Figure 6.3, assuming the case of a successful cluster.

Figure 6.3 Graphical illustration of the long term process of building a knowledge-based cluster (assuming the case of a successful cluster.)




As the above figure indicates, the process of cluster building cannot be expected to generate an impact in five or ten years. In particular, many clusters aim at addressing the structural problems of a region or the building up of a specific regional technological capability. If successful, as exemplified by Figure 6.3, these kinds of transformation are slow to occur and take time to generate observable impacts. The long term perspective of cluster building has significant implications for policy makers. A government intending to build a cluster should prepare to adopt a long-term approach, rather than expecting, like the governments of Hong Kong and to a lesser extent Scotland did a quick remedy for their economic problems. An understanding of this long term perspective also helps develop a consensus in society, thus avoiding conflicting expectations between the government and the public.

Besides, the evolutionary cluster building process in the two regions demonstrated the following characteristics: 1) path dependent nature; 2) inability to predict a definite result; 3) mutual shaping between the structure and the actors. First, with the path dependent nature of technological development, the cluster building processes in the two regions have been limited, by their respective structural problems and weak technological competence, from the outset. The routines of the existing firms and research organisations in the two regions further constrained their networking and learning activities in the clusters. Moreover, owing to this path dependent nature, a drastic change brought by the cluster building policies tend to cause huge disruption to the actors of the two regions and provoke their resistance to the policies. Therefore, governments building clusters should introduce incremental change, which may increase the chances of success. Second, despite the deliberate efforts of the two regions' governments to introduce cluster policies, it is hard to predict the outcomes of these policies beforehand as contingencies and difficulties may occur during the development of a cluster. In view of this, it is unwise for a government to adopt a single 'best' way to manage a cluster in advance, but rather it should take a very flexible approach, by constant evaluation, communication and learning, to re-align its policy according to the cluster's development and the change of the environmental context. Third, in spite of the path dependent nature, deliberate policy intervention, together with the participation of the actors in the cluster policy programmes, may help gradually modify the structural environment. An understanding of how these dynamics work can help encourage the co-evolution process and thus foster the growth of a cluster.

Many governments who intend to create clusters usually pay most attention to creating abundant 'factor conditions', while under-estimating the importance of the 'processual' dimension of cluster development. In short, the longitudinal analysis of the cluster building process in Scotland and Hong Kong provides many lessons of how to approach the cluster development process. For instance, the re-alignment of the cluster policy programme may help overcome bottlenecks and problems in the cluster development process, whilst also encouraging the steady build up of a cluster's momentum, which help shake up the old patterns of ineffective innovation and technology development. Nonetheless, it requires the government to carry out evaluation exercises at the multi-level cluster environment to bring about favourable changes in the various aspects of the socio-technical constituency. This necessitates a strategic, long-term cluster policy, which constantly assess the current and future technological, economic and social needs and problems, whilst keeping awareness of the technological trends and associated commercial opportunities.

### c. Cluster building as a multi-level learning process

Many scholars suggest that technology development is a complex learning process, through which knowledge is transferred from one organisation to another together with a gradual build up of technological competence. Clusters can help facilitate this learning process both at organisational and cluster levels.

At the organisation level, the learning process is enhanced through the presence of multiple sources in a cluster. The traditional approach assumes the linear nature of technology development and acknowledges simple channels along which science and technology input might flow. However, the cluster approach emphasises the learning process occurring with different actors and in different domains. For instance, the innovation system approach particularly highlights the learning that takes place between users and producers, as well as the knowledge spillover from public research sectors to private sectors. Therefore, firms in a cluster are in a better position to capture the STI and, by learning from these actors in the cluster, can help increase the innovation opportunities. Besides, it is unwise to think of innovation simply in terms of 'technology'. As noted, cluster building is a complex process which involves the domains of finance, marketing, organisation structures, training, relationships with customers and suppliers, and competitive positioning, whilst learning activity takes place in all these processes. For policy makers, the implication is that providing support for R&D activities alone may be ineffective in promoting technology development. Rather, encouraging organisational learning may be more productive. In view of this, governments should try to foster interaction and communication between users and producers and among a wide range of other actors in the cluster.

At the cluster level the traditional perspective seems to focus on developing technologies by means of the technology push approach. However, the cases of Scotland and Hong Kong highlighted the importance of 'coupling' technology push and demand pull in technology development. Learning in a cluster does not only happen in the innovation process, but also through the diffusion and application of technology by a diversity of demand side actors, ranging from the technology users, financial sector and potential actors of the cluster and a number of interface organisations. Therefore, cluster policies to encourage technological demand may have a positive influence on innovation activities. Learning capabilities are also of importance for overcoming obstacles at the cluster level. The cases of Scotland and Hong Kong illustrated that many problems of the clusters were not about the technologies, but the design and the implementation of the cluster policies. The evolutionary approach highlights the importance of what has been learnt during the cluster building process and how to improve the cluster building policies accordingly. Although there is no standard method to build a cluster, effective learning about the cluster building process can help enhance the chance of success.

### ii) Importance of goals, motivation, perception and actions in cluster building

#### a. Importance of perception and goals

Successful technology development requires changes at regime level in which perception, mindset and routines are embedded. Without a new mindset to favour technology development, a fundamental technological change is unlikely to happen. (Rip and Kemp, 1998) Scotland and Hong Kong both showed a lack of understanding about the importance of technological development in their cluster building processes because they were constrained by cultural factors such as an aversion to risk taking and concern with short-term results. Both are hostile to large-scale technology development which requires risk taking and long term investment.

Traditional economic models assume that profit is the main motive for innovation and that firms will respond directly to profit-related signals. The cases of Scotland and Hong Kong showed that different actors have different perceptions and are motivated by different things. Since technology development means different things to different actors, it is important to promote the achievement of consensus about the understanding of the cluster amongst different actors. Besides, owing to the diversity of the actors' perceptions of, and expectations from, clusters, the government should be flexible enough to use various forms of incentives to motivate them to take part. The government can also encourage communication amongst the actors from different backgrounds, so as to help actors to develop unified perceptions and goals regarding the cluster.

#### b. Purposive action

One of the central beliefs of the evolutionary approach is that the generation of diversity is an intentional and guided behaviour. (Hodgson and Screpanti, 1991) The two cases of Scotland and Hong Kong also demonstrated the purposive nature of cluster building. This gives a productive role to the government to guide the cluster building process to the desired direction through defining the vision and formulating cluster strategies to achieve it. Realising a vision is a long term process which implies that it is the perceived, rather than the immediate, benefits of the vision that influences the decision of the actors to take part in the cluster. The government that wants to promote clusters has to develop and use well a 'discourse' to convince the actors that the vision is both feasible and highly rewarding to those who commit to it.

Although there is a possibility for the government to intervene in cluster development, the two cases of Scotland and Hong Kong also showed that actors of the two clusters were against the 'top down' approach in building clusters. This reflects the belief that central planning and control is not the best way to build clusters. Instead, the government can guide the cluster building process by acting as a facilitator and by using a variety of mechanisms to encourage actors to collaborate, to learn and to communicate with each other in the cluster.

**iii) Designing a cluster strategy**

**a. Focused vs diffused technology targets**

There are debates on whether a government should focus on investing in one or a number of technologies to build a cluster. Many scholars argue against the former approach because it is very similar to the 'winner picking' approach. Any change in circumstances, such as a shift of technological paradigm, may bring disastrous results to the cluster if the government is narrowly focused on one technology. The cases of Scotland and Hong Kong showed that despite a wide range of technologies being picked by two governments as technology targets of the clusters at the early stage, the scarcity of resources and the evolution of technologies, a technology 'winner' emerged naturally in the later stages. The lesson of the case studies is, that although it will be costly to develop several technologies simultaneously, a government may maintain a level of flexibility at the beginning of cluster development and subsequently adopt a more focused approach after the emergence of a particular technology 'winner'.

Adopting a more diffused approach at the beginning of the cluster development does not mean that a government can build a cluster around any technology. The cases of Scotland and Hong Kong demonstrated that a cluster should be built on a technology which has already got a local foundation, that is, choosing technologies in which companies have established a solid technological competence within existing markets. It is also a less risky way to build clusters since private sector involvement can help reduce government's investment and level of intervention.

### b. Radical vs incremental change

The cases of Scotland and Hong Kong also showed that cluster building will have a better chance to succeed if the changes are incremental. As noted, a cluster should be built on a established technology because completely new technologies and new competencies take time to develop. Besides, a government supporting a great technological leap has to make large scale interventions, which are more complicated and difficult to carry out. In Scotland and Hong Kong, the two governments wanted to develop the microelectronic design industries which were almost non-existent before the introduction of the cluster strategies. The two governments not only had to create the infrastructure for the industry, but also attract inward investors in microelectronic design to build up the critical mass and train up or import talents to meet the human resources needs. Despite all these efforts, the results are not particularly impressive since the anticipated new competencies have not yet developed in the region. Therefore, to enhance the chance of success, policies to develop clusters should focus on small steps and incremental changes. (See Appendix 8 for the discussion of the 'Transition Management Method' for introducing incremental changes)

## iv) Implementation of cluster policies

### a. Importance of the implementation of cluster policies

The governments of Scotland and Hong Kong, when building their clusters, tended to focus on creating favourable 'factor' conditions, such as the construction of physical infrastructures and provision of financial resources for technology development. Yet, like many other governments, they were inclined to overlook the importance of the implementation of their cluster policies. In fact, the two cases demonstrated that investing abundant resources is by no means a guarantee of the success of the cluster policies. Common mistakes in the implementation of cluster policies include governments usually assuming that information about cluster policies is widely accessible to cluster actors, so that they will be willing to follow the government's plans and take part in the cluster whilst changing their routines accordingly. Unfortunately, the reverse of this assumption is seen in the two case studies. Many cluster actors were ignorant of the government's supporting programmes and were not ready to change their practices. This highlights the importance of promotion and dissemination of information about cluster policies to the actors through a variety of channels. Besides, the cluster building process itself is a long term learning process. Governments implementing cluster policies have to pay attention to the post-adoption period of various initiatives, so as to adapt and optimise policies to meet the changing needs of the actors and the environment.

#### b. Interface organisations

One of the ways to improve the effectiveness of the operation of clusters is by making use of intermediaries. The reasons are twofold: first, technology development is a complex process and inputs for innovation may come from many actors. The intermediaries can help create links among different actors so as to facilitate the interactive learning process to take place. Second, cluster building requires cooperative actions among different actors who are from different backgrounds, technological capabilities, specialisations and cultures. The intermediaries can act as agents in managing the communication channels and ensure effective inter-organisational cooperation within the cluster.

The government which initiates a cluster can take on this intermediary role to help create links among actors in the cluster. Apart from directly being an interface agent, the government can also indirectly support a number of networking organisations to play this role. The case of Scotland showed that sometimes networking organisations can perform better than the government due to their independent status and freedom from conflict of interests with other actors in the cluster. Examples of these networking organisations include the university technology transfer office, which acts as a lubricant to facilitate collaboration between universities and industries and to enhance the effectiveness of the technology transfer and commercialisation process. Some of these networking organisations cannot only facilitate one to one collaboration, but also multiple collaboration in the cluster. Networking organisation such as 'Connect' of Scotland successfully acted as a 'bridging organisation' to link many technology start-ups with venture capital firms.

### c. Market leaders

Another important aspect of the implementation of cluster policies is the cultivation of a 'market leader' in the cluster. Many scholars of clusters have emphasised the importance of having a market leader in the cluster, which out-sources various production processes to other actors and acts as a mother company by spinning out other 'daughter' companies. The cases of Scotland and Hong Kong showed that in addition to these, a market leader can also deliver a crucial 'demonstration effect' to other companies and encourage them to follow suit. For instance, the Scottish government encouraged Cadence to be a partner of the Alba Project, whilst the Hong Kong government persuaded Philips and Microsoft to be the anchor tenants of its science parks. This marks a crucial role for the government in identifying the market leaders of a particular industry and persuading them to take part in the early stage of the cluster development. If they succeed in this, there will be a greater chance for other companies to follow the example of the market leader and take part in the cluster, thus helping build a critical mass for the cluster. Besides, the presence of a market leader in the cluster serves as a role model and shows other actors what they can achieve in the cluster. This may further encourage them to participate in the cluster and adopt the practices of innovation, networking and learning.

### d. Critical mass and momentum building

As mentioned earlier, there are certain non-malleable elements in technological development which actors have insufficient power or resources to modify. For instance, technological development tends to follow trajectories that are difficult to break. In this process, the mindset and routines of actors lead to certain forms of 'irreversibility'. When these routines or mindset operate at a collective level, they cannot be changed easily by the effort of one actor. In view of the above, it requires a critical mass to create a 'cumulative effect' or momentum to pass the threshold and establish a new 'trajectory'.

One of the problems of the Scottish and Hong Kong ICT clusters is that they do not have a sufficient critical mass to build the momentum for change towards a knowledge-based cluster. On one hand, the number of ICT companies in the two clusters is too small to deliver a 'bandwagon effect' to attract a large population of ICT companies to follow them. On the other hand, the small number of ICT companies makes them difficult to identify the complementarities among them and bring out the synergy effect in a cluster. However, when a crucial critical mass has been established, and when these companies truly commit themselves to technological development, they may bring out the ‘cumulative effect’ and deliver sufficient momentum to break the existing trajectory and introduce a new one. In this way the momentum helps accelerate the innovation process, leading to the rise of a new technological trajectory to replace the old one.

**e. Cultural dimension**

When implementing the cluster policies government should be sensitive to the cultural issues which may affect the effectiveness, and even the results of the cluster policies. First, the operation of actors in a cluster is affected by the culture of their respective organisations. The cases of Scotland and Hong Kong showed that different actors in the cluster, including government, local or foreign companies, academics and financial organisations all have very different cultures which affect their way of operation in a cluster. For instance, many venture capitalists are quite conservative in Scotland, regarding technology development as very high risk and are therefore more reluctant to invest in technology ventures. Traditional academics, like those in Hong Kong prefer conducting radical and blue sky research which may take a few years to complete, in contrast with the industrialists who seek research results which are of immediate application. To facilitate cooperation among them, it is necessary to develop open communication channels to enhance the understanding amongst each other.

Apart from the diverse culture of different organisations, cluster promoters have also to pay attention to the cultural pattern or milieu embedded within a particular region or country. When implementing cluster policies in different locations, a mis-match with the local culture may cause the policy to fail. For example, the government policies to encourage networking may come across more difficulties in Scotland because the region does not have a strong relational culture. The resistance to networking seems to be less strong in Hong Kong due the fact that networking behaviour is embedded in the Chinese culture. Moreover, both regions of Scotland and Hong Kong do not have a tradition of central planning on policy issues. This explains why the actors of the two regions object to the implementation of a top-down cluster policy. However, the effects of a top-down policy may be different in countries like China and Singapore, since the people in these two countries are more likely to accept central planning of government policies. In short, cultures may play a role in shaping the outcomes of cluster strategy. To avoid opposition and maintain high level and sustainable support, cluster builders need to recognise and respect the different actors' concern to safeguard their cultures and traditions. Governments have to find ways to introduce cluster policies without generating too much social conflict, which is an important condition for a cluster's success.

### v) Evolution of clusters

#### a. Co-evolutionary process of cluster building

The ten year longitudinal study of the cluster building processes in Scotland and Hong Kong clearly demonstrated that a cluster does not remain static overtime but is constantly evolving. This evolution process is caused by the prolonged interaction between structure and actors in the cluster. As observed, certain 'irreversibilities' exist in clusters, such as the industrial structures or specific technological competence. They are the legacies of a number of historical developments and are difficult to change. These 'irreversibilities' constrained certain aspects of technology development, including the ability of companies to carry out innovation or the level of success of the clusters. However, the actors' strategies and the dynamics induced by their collective actions can help modify these 'irreversibilities' and re-shape the cluster. At the end of the study period, the clusters of Scotland and Hong Kong have changed both in terms of their structural characteristics and the perception of the actors in the clusters.

The implications of this co-evolutionary nature of cluster development are twofold. On one hand, it recognises that cluster development is being influenced by exogenous factors, such as economic structures and market conditions. On the other hand, it also confirms the importance of endogenous factors, in particular firm strategies and actions, in determining roles in cluster building and evolution. Besides, when the cluster evolves along its path of development, a number of new factors and actors have to be taken into account. For example, government has to persuade new actors to take part, sign up new agreements with foreign governments, seek to develop new technology to keep up with the emerging technology market. This suggests that the process of cluster building cannot be set out beforehand, but governments have to keep a watch on the cluster development. The evolving nature of cluster development implies the need to move away from standard policies to a more flexible approach in the design and application in the cluster policies.

#### b. Variety, selection, feedback and alignment

Metcalfe (1994) points out that variation and selection are two crucial dimensions of technology policies based on an evolutionary economic approach. Variation refers to the process through which innovation is introduced to the economy, whilst selection means the process of choosing from competing alternatives. An understanding of these two dimensions is important to cluster development. To enhance the variety of innovation input, promoters of clusters have to set a policy goal to enhance the opportunities for idea generation through improving the effectiveness of the learning process. The learning process can also improve the process of selection over time. The more companies engage in innovation activities, the more can they learn effectively, thus enabling them to select and use appropriate knowledge for technology development.

In the evolutionary process feedback plays a crucial role in facilitating variation, generation and selection. At the company level, feedback from users not only helps shape the direction of a particular variation generation process, but also facilitates the selection of variation to take place. At the cluster level, the feedback from cluster actors contributes to the improvement of the cluster policies. It helps to introduce variation into the cluster building process. It is also of particular importance for the socio-technical re-alignment process. The feedback from actors sends signals about the direction for change and improvement, which helps generate appropriate force to transform the 'irreversibilities' of the cluster. As a result of the feedback loops and the dynamics of actors' strategies, variation takes place at both company and cluster levels of the cluster. The co-evolutionary process of these interacting levels ultimately transforms the 'irreversibilities' of the clusters and overcomes the constraints on technological change.

### vi) Diverse cluster building processes

#### a. Diverse contextual environment

The two cases of Scotland and Hong Kong illustrated the divergence of the cluster building processes. This was caused by a number of factors. First, for a variety of historical, cultural, political and economic reasons, nations differ widely in their financial systems, education systems and regulatory regimes. They also have different scientific and technological resources and technological specialisms. All these mean that all clusters have different contexts and institutional set ups leading to a particular cluster building process. Second, the technological capabilities in Scotland and Hong Kong are not the same and different instruments are required to build their respective technological capabilities to reach their specific visions. Third, the authorities of the organisations which are responsible for cluster building in the two regions are not equal. In Hong Kong, cluster building is handled by a special commission (the Innovation and Technology Commission) within a government bureau, whilst in Scotland it is handled by a special group (the Cluster Team) inside an economic development agency. This difference may have an impact on the level of intervention in the implementation of cluster policies. As a result of the above differences, each cluster is unique. Even though some of the initiatives implemented by Scotland and Hong Kong are quite similar their impact on the cluster development may vary.

Therefore, a region should avoid implementing a standard cluster policy and instead design policy measures that address the special needs of various actors in the region. Nelson (1993) also points out the problems of imposing homogenous technology policies internationally. First, some of the standard policies may clash with a country's beliefs about the appropriate role for the government to play, resulting in the rejection of the policies by the actors. Second, he also argues that in view of the high degree of uncertainty in technology development and global markets, for the sake of long term efficiency advantages, it is better not to reduce diversity and curb creative approaches in technology development.

#### b. Diverse dynamic of different technologies

Although the two clusters of Scotland and Hong Kong were building on the same technologies—ICT, the cases illustrated that different technologies have different dynamics and their cluster building processes are somewhat different. For example, the cluster building process for an emerging technology would be different from that of a mature technology. One of the mistakes committed by the two governments is that they focused too much on the technology push approach, which should be more appropriate for building clusters based on emerging technologies such as biotechnology and nanotechnologies. On the contrary, for more mature technologies, such as consumer electronics or semiconductors, their innovation processes are driven by demand pull. This implies that cluster builders should pay attention to the dynamics of different technologies at their various stages of development and tailor their cluster policies to meet the needs of their specific technologies.

In addition to the technologies which are already developed in the region, governments should pay attention to new technologies in the region. These new technologies may disrupt the existing trajectory and create a new one. For instance, some disruptive technologies may cause disastrous results to a region if their cluster narrowly focuses on one specific technology. (The ship building industry in Scotland is a case in point) The development of a new technology may require a shift in the contextual environment and the actors. This may mean that the old technology policies are obsolete and a different set of technology policies are needed to meet the needs of the new technology. Rigidity and lock-in of a region are the results of failing to recognise the shift of the technology trajectory. To avoid this happening, cluster builders should expect that technological changes may take place all the time and keep monitoring the technology development. Besides, in order to address the consequence of the maturity of technologies and rise of new trajectory, cluster builders have to maintain flexibility in designing their policy instruments and implementing their cluster strategies or initiatives. A re-allocation of resources and re-design of their cluster policies is likely to be needed when the technology target has changed.

### 6.3.2 General steps to build a cluster

Despite each cluster building process being different, the cases of Scotland and Hong Kong suggest the existence of some general steps. In the following, these are summarised into ten steps.

#### 1. Identifying problems/opportunities and setting visions

As Molina (1990, 1993) points out, a technology cluster can be driven by technology opportunities or problems. Therefore, the first step in building a cluster is to identify such problems and opportunities. The cluster building processes in Scotland and Hong Kong, as the previous chapters showed, were driven by their 'problems'. The problem identified in Scotland was the decline in its traditional ICT manufacturing industries due to the re-location of MNCs to low costs economies, whilst the problem in Hong Kong was recognised as arising from the reduced profit margins of its OEM based ICT equipment manufacturing industries and stiff competition from neighbouring countries. Therefore, the two governments decided to solve their 'problems' by building a knowledge-based technology cluster.

After acknowledging the problems encountered by the two regions, the two governments began the cluster building process by defining a vision for their technology clusters. The visions of the two regions were defined as a solution to their problems. The realisation of the visions would occur when their respective problems are solved, which would represent the ultimate success of the cluster. Accordingly, the vision in Scotland is defined as 'to be one of the world's most enlightened locations for the next generation of systems and silicon designers, developers and manufacturers', whilst the vision of Hong Kong is 'to become the innovative centre of southern China and the Asian region'. These two visions encapsulated an image of Scotland and Hong Kong after their visions had been fulfilled and their respective problems solved.

**2. Taking an initial step to kick start the process**

Despite the governments of Scotland and Hong Kong having recognised their problems and identified the building of clusters as their solution, the two governments did not take any actions to kick start the process but were distracted into a long debate, lasting almost five years, about whether to build a cluster. Their inaction became one of the greatest obstacles for their cluster building process. The inability to make a decision (either accepting or rejecting the option) not only reflected the underlying doubt of the government, but also revealed some of the major actors' disbelief about the feasibility of their vision as well as their abilities to realise it. In short, the kick start of the building processes of the two clusters was hindered by the perceptions of the actors.

This indicates the government has to find a creative solution to overcome these kinds of negative perceptions since they will hinder the actions of cluster-building initiated by the government. As the two cases showed, one of the solutions to these perception problems is to let the actors know what would accompany success of the clusters, such as the possible benefits to the industries and the regions. The cluster building cases of Scotland and Hong Kong showed that the actors' perception would have crucial impact on their behaviour and hence affect the success of the cluster. Therefore, knowing what the cluster can achieve may help motivate the actors and change their perceptions and actions accordingly.

### 3. Understanding regional characteristics and carrying out mapping exercise

As observed, every region is unique and bears specific characteristics. To build a cluster the government has to identify the specific needs of a region or sector and design cluster policies to meet them. Carrying out a mapping exercise is an important step to understand the unique resources, strengths and weakness of the sector or region prior to the designing of cluster strategies. When conducting the mapping exercise the government can also use other successful countries and regions as their model and carry out benchmarking exercise.

The mapping exercise should truly reflect the situation of the sector or region, and should be as detailed as possible. Sometimes countries carry out a mapping exercise merely to take stock of the quantity of their technical constituents, such as the existence of certain infrastructures for technology development, whilst overlooking the qualitative aspects associated with the social constituents, such as their perceptions, willingness to accept changes and their goals. The more a government learns about the real situation of the region or actors, the better policies it can design to address the cluster's needs. This ultimately will help bring out the region and actors' full potential. On the contrary, if the mapping exercise fails to reflect the true situation, there will be a chance that the government may choose the wrong technology or design an unsuitable policy.

### 4. Choosing the strategy (variation and selection)

Once the government has acknowledged the genuine situation of a specific sector or region, it can choose an appropriate strategy to improve the situation. Choosing a strategy means selecting from a wide variety of solutions. For instance, the government has to decide whether to direct its policies at firms, or to focus on a specific technology. If the latter, the government has to be aware that each technology has its own dynamic of knowledge generation and accumulation, and different institutions and actors, including overseas ones, are involved in the process. Besides, the government needs to decide an appropriate approach to implement its chosen strategies. Options include: to support the development of technological artefacts, to enhance the innovation possibilities by facilitating network building, to encourage technology diffusion and learning, to strengthen technology skill training and development. When selecting the solutions, governments must understand the advantages and disadvantages of each one and select approaches which can effectively address the problem.

Choosing a strategy is only a first step to initiate changes. It should be noted that the choice of cluster strategy merely gives a general direction to solve the problem, it does not mean that the strategy is set in stone and cannot be changed. In fact, the cases of Scotland and Hong Kong showed, despite the similarity of the cluster strategies adopted, these strategies were implemented differently. Also their cluster strategies did evolve differently along the path of creation and development. Therefore, the government should choose a cluster strategy at what they consider to be the appropriate time, and then follow the strategy, whilst learning on the way. However, it is unrealistic to assume that a government has a supervisory understanding of technological opportunities or market behaviour. A government, impaired by limited information or political constraints, may select a wrong strategy that leads to the failure of the cluster. When the strategy fails to reach its intended purpose, the government may have to select a new option, either to modify the original strategy or to adopt a new one. The key is to learn along the path and adapt the strategy in light of the lessons.

Another important aspect about the selection of strategies is the perception of the actors, in particular, their beliefs in the strategy and willingness to carry it out. Without a positive perception it is difficult to encourage the actors to take part and implement the strategy to improve the situation. The boldness and determination of the cluster leaders will also have strong impact on the actors' perception. Cluster leaders should believe in the vision and have confidence in the region's ability to realise it. The two cases demonstrated the importance of cluster leaders having faith in the chosen strategy and a willingness to act boldly in defence of the strategy when facing criticism, especially at the early stage of the cluster building process. In order to convince and persuade the actors, cluster leaders may use 'discourse' to illustrate the future benefits to them. For instance, in the case of Hong Kong, the Chief Executive kept repeating the cluster vision and how it would benefit Hong Kong's future and global competitiveness on numerous occasions. His earnest persuasion successfully convinced the Hong Kong community about the importance of technology and innovation in the region's future, and they seemed to accept the cluster vision at last, showing how their perception of technology development had changed.

**5. Setting of goals**

In following the choice of cluster strategy, the government has to set up a number of goals for its cluster. It is worth noticing that a vision is different from a goal. The vision is the big picture of how things will have changed after the success of the cluster strategy, whilst goals are more numerous and specific aspects of the change. Also a vision remains static over time, whereas goals can be changed according to the stage of development. As has been stressed by various scholars, a goal should be specific, measurable, attainable, realistic and attached to a specific timetable. There are three functions for goal setting: first, it acts as a guidepost to show the right direction towards realising the vision; second, it provides important check points for cluster stakeholders to judge their cluster building efforts; third, the successful achievement of a goal can motivate the actors to continue their effort to realise the ultimate vision.

Unfortunately, many governments always make mistakes when they set their goals. One of the common mistakes is the mixing up of visions and goals. In the case of Hong Kong, the Government declared their vision as 'becoming an innovative centre of Southern China and Asian region'. However, they have not set any specific goal. Neither did they set up any timetable for reaching their vision. This deterred many actors of the cluster because the vision seemed to be too vague and difficult to achieve. For the case of Scotland, although a specific, measurable target has been set and a timetable has been attached to it, their goals were too ambitious and unrealistic in view of the situation at that time. The measurable goal of the Scottish ICT cluster was '*to have 14,500 people working at the microelectronic industry, among them at least 5,000 employees in design, development and application*' by 2004. This goal was difficult to attain, as prior to the launch of the cluster strategy in Scotland, the number of employees engaging in microelectronic design was very small and the majority of the workers were engaged in the traditional semiconductor production industry. By 2005, there were only about 1,400 employees in microelectronic design instead of 5,000. The big gap between the number achieved and projected showed that the goal set by the Scottish Government in 1999 was unrealistic.

Another aspect about goal setting is that a goal should be articulated and made known to the stakeholders of the cluster. The interview results showed that the governments of Scotland and Hong Kong failed to communicate the clusters' goals to their stakeholders and many cluster actors were ignorant of them. This defeated the purpose of goal setting as the objectives of goal setting mentioned above cannot be achieved. Besides, when a cluster fails to reach a goal it does not mean that the goal is totally wrong or all previous effort has been futile. For example, Scotland could not achieve the planned number of microelectronic designers by the prescribed date, but this did not mean that they have set a wrong goal, rather their timetable was highly optimistic. Therefore, they just need to remain committed to the goal but revise their timetable to a more realistic time scale.

**6. Designing cluster action plan and implementing cluster policies**

Following the setting of goals, the next step should be to map out a detailed plan to realise the goals. An action plan is a blueprint which assists the government to understand what actions and resources, such as time, money and human resources, are needed to reach the goal. A well designed plan, based on a thorough analysis of the situation, can enhance the chances of success for the cluster. It enables cluster builders to channel resources to the areas most in need and to manage and control a number of elements in the cluster building process, thus helping to ensure the cluster programmes operate smoothly and according to the timetable.

Implementation is just as important as planning. There is no formula for implementation, but the general steps are summarised as follows:

1. Break down the goal into multiple tasks and outline the actions required to reach each goal.
2. Identify all the actions and then prioritise them according to their levels of importance and urgency
3. Select a few important actions and commit resources to their launch
4. Legitimise these selected actions through the institutionalisation process
5. Acknowledge the results of these actions, even if only a little progress is made. The early success can boost the confidence of actors and facilitate the launching of more actions
6. Launch out actions one after another because momentum can be built up by accumulation of success
7. Monitor the progress of each action and collect feedback from actors, whilst modifying actions when necessary

Sometimes, implementing new policies is difficult and the government has a role to play as a facilitator to make the process easier. The government can help kick start the cluster building process by encouraging cluster stakeholders to take their first step in participating. For example, the government can motivate actors to break their old routines and engage in innovation activities by providing incentives. Once the first step has been taken, the process may move forward more easily. Therefore, the key is not to make a perfect plan, but to start the process and modify the actions along the path when more knowledge is gathered. Through ‘learning by doing’, the actions can eventually lead to the realisation of the goals.

**7. Building of momentum**

Momentum can be built up by the accumulation of little successes. At the beginning cluster builders introduce a few initiatives as a test. When these initiatives begin to achieve results and the stakeholders taste the first fruits of the cluster policy, they are likely show more confidence in the cluster policies and become more willing to take part. Then the government can enlarge the scale of the cluster activities by increasing the number of meaningful initiatives and inviting more actors to take part. When the cluster initiatives achieve a higher level of success, the cluster actors’ confidence in the cluster policies will be further strengthened. They are likely to become active participants and naturally internalise the cluster activities as part of their routines. In this way momentum can be built up and a virtuous cycle can be created.

To sustain the momentum cluster promoters have to maintain the motivation of the stakeholders. This can be done in a number of ways. First, by acknowledging the success of the cluster initiatives. Success brings confidence and confidence can help bring more success. Second, by providing more support, including the allocation of more financial and human resources to the cluster programmes. Third, by showing the achievements of other successful clusters to encourage stakeholders to learn from their experience and borrow confidence from them. Fourth, by reiterating the long-term commitment and determination of the government to support cluster development. Finally, the key to sustain the momentum is to keep going, introducing one meaningful initiative after another. The success of each initiative can generate more dynamic and help motivate the stakeholders to keep going. Together with the external support and motivation from the government the cluster will move forward to realise its goals.

**8. Learning from setbacks**

The cases of Scotland and Hong Kong showed that sometimes problems will emerge from no where to disturb the progress of the cluster building process. Examples include, the 9/11 incident, the global ICT downturn, the Asian Financial Crisis, and the outbreak of SARS. No government can predict such events when they design their cluster strategies. This implies, on one hand, that fortune is an important factor affecting the success of a cluster, and, on the other hand, the continuous development of a cluster really depends on the abilities of the cluster builders to overcome problems.

As we have seen, both Scotland and Hong Kong faced problems when they built their clusters. As a result the ICT industries in the two regions recorded a remarkable decline, despite the governments investing heavily in their cluster strategies. Although problems are not welcomed, they can provide invaluable lessons for the cluster development process. For example, during the global ICT downturn, cluster stakeholders in Scotland learnt that their traditional low cost ICT manufacturing was unsustainable. They also realised that the inward investment approach was unable to solve their structural problems, as the MNCs would move away easily. After the economic setback the Scottish Government shifted their inward investment approach to support the growth of indigenous technology companies. The insights gained from the problem helped shape the future direction of Scotland's cluster policies.

The way in which the cluster promoters handle problems is also critical to the cluster's future development. Facing obstacles, cluster promoters can either choose to give up the plan or to solve the problems. Two very different attitudes were seen in the governments of Scotland and Hong Kong. The Government of Scotland did not give up but kept investing in the cluster development, whilst the Government of Hong Kong decided to shift their policy direction to support service industries instead of pursuing the development of high technology industries. In fact, for the case of Hong Kong, although the setback evoked a perception that the cluster had failed, the real cause could have been launching the cluster plan at the wrong time. Unfortunately, the Hong Kong government chose to revert to supporting the service industry under strong pressure to reduce economic turmoil immediately. This decision looked appealing at first glance, as it relieved the region's economic problems instantly, but eventually it diverted Hong Kong away from its original path of solving its structural problems by developing a technology cluster. In Scotland, the government was also tempted to revert to its inward investment approach when the region was facing economic problems. However, they soon realised that simply attracting more inward investors was not enough to solve their structural problems in the long term. Rather than going back to the old path, they decided to solve their problems by adjusting their approach and investing more resources in supporting the indigenous technology companies.

Their decision has enabled them to keep moving forward towards their goal of creating a sustainable technology cluster.

In spite of the temporary setbacks the previous chapters revealed that the two clusters had actually made some small progress. For instance, the resources for technology development have been increased, the networks among different actors have been strengthened, the technological capabilities of the ICT companies have been enhanced and the ICT clusters also started to generate economic benefits for the two regions. All these would not have happened without the launch of the cluster strategy. It is also encouraging to see that, after the continuous efforts of five to six years, the two regions have made a small step closer to their goals. Even though the two clusters have not achieved a major success, thanks to the valuable lessons they gained from the setbacks they came across, they are progressing in the right direction towards their goals. In short, problems can be regarded as part of the cluster building process. It would be wise for cluster stakeholders to anticipate such eventualities and take a positive attitude towards them. What really matters is not avoiding problems in the cluster building process, but learning from them and thereby solving them.

**9. Re-aligning cluster building efforts**

Once cluster promoters decide to solve the problems and to continue working towards the same goals, the re-alignment process can begin. Building on the experience gained from the setbacks, cluster promoters can revise their action plan and introduce appropriate actions.

The re-alignment process begins with an evaluation of the progress of various dimensions of the cluster, through which the achievements of the cluster policies are acknowledged and the problems are pinpointed. By acknowledging the achievements stakeholders can have tangible proof of the progress that has been made in the cluster building process. This enables them to understand where they stand and how far they are from realising their goals, thus helping motivate the cluster stakeholders to stay focussed and sustain the momentum. For those policies failing to obtain the projected results, they show where the mis-alignments are and show where the cluster promoters have to act. For instance, the governments of Scotland and Hong Kong discovered their technology-push approach, encouraging commercialisation of academic research, did not achieve very remarkable results due to the mis-match between this approach and the nature and maturity of their technologies. Therefore, in the re-alignment programmes both regions initiated a demand-pull approach, in which new initiatives, such as Intermediary Technology Institutes (ITIs) and R&D Centres (R&DCs), were introduced to develop new ICT research programmes based on industrial demand.

Apart from the alignment of policy instruments to get better results, an alignment of the cluster actors' perception to the cluster's goals is of equal importance. In order to achieve perception-alignment, cluster promoters can seek the opinions from various cluster stakeholders, as a means to improve the cluster policies. By understanding what these cluster stakeholders want, cluster promoters can design policies to meet their needs. In return, this can secure the actor's support for the cluster programmes and help actors to develop a positive perception of the cluster's goal. For example, both the governments of Scotland and Hong Kong embarked on large scale consultation programmes to collect the opinions of a wide range of cluster stakeholders. They not only articulated concerns about the cluster policies, but also identified the new technology focuses required for the cluster to develop over the next five years. The consultation became a crucial tool to help achieve a consensus among the actors and align their perceptions to the cluster's goals and policy programmes.

With the insights gained from the consultation exercise, re-alignment programmes can be designed and new actions can be introduced. However, it is not the end of the process. Even when the re-aligned cluster policies seem to go in the right direction problems will emerge again and mis-alignment will occur as circumstances change. The new problem may not be the same as the old, but it is important for the cluster promoters to keep monitoring and evaluating the cluster programmes from time to time, and to re-align their policy instruments and the actors' perceptions in line with the cluster's ultimate goals.

**10. Cluster building as an evolutionary process**

The evolution of a cluster means that the cluster building process is not an end in itself. When a cluster reaches a certain level of maturity changes will take place. Regardless of the process involved, a convergence of several technologies to form a larger technology cluster (like the semiconductor cluster in Scotland blending with optoelectronics and communication technologies to form an enlarged ICT cluster), or a geographical enlargement of a regional innovation system to a national one (like that of Hong Kong's integrating with the greater Pearl River Delta region in China), will bring changes and new challenges to the existing cluster. Therefore, it is necessary for cluster promoters to step up their efforts and to make new arrangement to deal with these challenges and opportunities. By monitoring and being fully informed about the latest development of the cluster, cluster promoters can prepare for these changes and help make the transition a smooth one.

As the evolutionary process continues a successful cluster will move closer to its goals. New challenges and opportunities will accompany each stage of development, as will problems and lessons for the actors to learn. However, cluster promoters need not apply the same method to these challenges because they have gained new insights and experience. The key issue in this evolutionary process is to keep focusing on the vision of the cluster. Despite changes taking place, the ultimate vision of the cluster will not be lost. If the cluster builders have prepared for change by monitoring the emerging technology trajectory and by tracking the geographical expansion of the cluster, they will not be caught out and will be able to seize the new opportunities created by the evolutionary process.

Summing up, cluster building is a journey to realise a specific high tech vision in a region. After a goal has been set, cluster promoters can design the strategy and action plan to achieve the goal. Cluster building is also in a constant state of activity, as plans have to be translated into actions. Cluster building is a process that never ends. When the cluster evolves and reaches a new stage, new opportunities and threats will arise, and the cluster promoters have then to begin the cluster building process all over again. Cluster building is also a path of learning. Problems may hinder progress but is here that the learning process takes place. The insights gained from the overcoming setbacks will assist the next step of the journey. In this way a cluster moves from one stage to another, and finally may reach its destination—the building of a competitive advantage (in the form of technological capabilities) in a region. The success of the cluster building process depends largely on the determination, concentration and commitment of the cluster stakeholders, together with their ability to learn lessons during the process of cluster building.

### 6.3.3 Governance issues of cluster building

#### 6.3.3.1 Taxonomy of factors contributing to successful cluster building

Based on the interpretation of the empirical cases, a number of factors contributing to successful cluster building can be identified. A taxonomy of these factors is summarised in Table 6.4 with the aim of providing a basic checklist for cluster promoters to conduct a systematic review on their cluster building processes. It is hoped that the categorisation in the taxonomy can assist cluster promoters to understand the complex nature and the important factors in the cluster building process, thus enabling them to design more effective policy programmes to foster the cluster development.

Table 6.4 Taxonomy of factors contributing to successful cluster building process

| **Context-related factors** |
|---|
| • **Factors related to general economic environment** |
| General character of the region: GDP, sectoral composition, population |
| High education level of workers |
| High level of entrepreneurship |
| A good strong economy |
| • **Factors related to industrial environment** |
| Appropriate industrial structure: number, size and ownership of firms |
| Autonomy of foreign subsidiaries |
| Strong indigenous sector |
| General patterns of innovation: R&D intensity, networking, appropriability condition |
| • **Factors related to technology environment** |
| Nature and maturity of technology |
| Level of technological capability |
| Strong science base |
| General technology policies: R&D expenditure, IPR protection |
| Existence of sites and facilities: science park, communication infrastructures, R&D equipment |
| • **Factors related to geographical characteristics** |
| Geographical location, history of geographical agglomeration |
| Special historical incidents |
| Special local resources |
| Generic cultural factors: hard working, network culture, attitude towards risk, etc. |
| **Content-related factors (content of a cluster)** |
| • **Factors related to firms** |
| ***a. firm level factors*** |
| Existing knowledge base and innovation and entrepreneurship capabilities of firms |
| Firm's technology management competence |
| Organisation of production: flexible specialisation regime |
| Technology strategy of firms: leader, imitator, follower |
| Firm's best practice of technology diffusion and absorption capability towards external knowledge |

| |
|---|
| Presence of sophisticated customers<br>***b. cluster level factors***<br>Presence of a flagship company to act as the cluster leader<br>A critical mass of technology firms<br>Firms with complementary assets and capabilities<br>Propensity to linkage: among related firms and with public sector research (PSR)<br>Intensity of competition among firms: abroad and at home<br>• **Factors related to PSR**<br>Presence of technology expertise in PSR<br>Quality of education and intensity of research in PSR<br>Propensity to link with industry<br>Best practise of technology transfer and commercialisation of academic research<br>• **Factors related to government**<br>Supportive national and regional governments<br>Provision of public funding<br>Policies to nurture the growth of networks<br>Policies to foster the indigenous economy<br>Role of government as a key buyer/user<br>• **Factors related to supporting institutions**<br>Availability of investment capital and dynamism of venture capital businesses<br>Availability of local services: accounting, legal, consultancy services, etc.<br>Presence of incubator organisations<br>Presence of intermediary organisations or interface mechanism to promote linkages<br>Presence of life-long learning and training support institutions<br>• **Factors related to cultures**<br>Presence of competitive pressure and associative cultures<br>Culture of knowledge sharing and exchange<br>Attitude towards risk taking and entrepreneurship<br>Free flow of new information<br>Presence of trust based informal linkages<br>Favourable attitude to technology and science among the young generation |
| **Process-related factors** |
| • **Factors related to cluster policy design**<br>System-oriented view of economic development<br>Government understanding of the industries, regional characteristics and business operations<br>Identification of potential technology areas already present in the economy<br>Mapping out networks among firms and industry-PSR linkages |

Identification of weaknesses in the cluster value chain and design policies to fill gaps

Defining common goals and strategies, design policy programmes

- **Factors related to cluster policy implementation**

Public agents pool resources to build clusters

Public agents act as catalysts to kick start the process

Promotion of cluster policy programmes and mobilisation of public participation

Provision of leadership and direction

Acting as interface instruments to encourage cooperation

Initial problem solving and facilitating cluster building process

- **Factors related to the alignment process in cluster building**

***a. dimension I: constituent's perception, goals, actions, resources***

presence of authoritative leaders or constituency builders

actors have positive perception towards cluster building

actors understand goals and plans of cluster building

actors willing to commit resources and take action to participate in cluster building

***b. dimension II: nature and maturity of technology***

alignment between the target technology and market trend

alignment between target technology and the technological capabilities of actors

alignment between cluster policies and the nature and maturity of the target technology

***c. alignment 1: governance***

presence of favourable government policy and mechanisms

presence of favourable market/industrial governance to steer and develop the cluster

***d. alignment 2: nature of target problem***

ability of the government and actors to learn from successes and failures regarding the target problem at each phase

government and actors committed to solving problems and mis-alignments at each phase

***e. alignment 3: target constituents' perception and pursuits***

government pays attention to potential resources and actors outside the existing cluster

government has plans to engage target constituents to become part of the cluster

***f. alignment 4: interacting technologies/constituencies***

paying attention to the interaction with other local and overseas clusters

paying attention to the growing maturity of existing technologies and the emerging of new ones

- **Factors related to cluster dynamic creation**

Strengthen demand and supply networks and industry-PSR linkages

Encourage industrial innovation, productivity and competitiveness

Capitalise spillover effects and externality benefits

Enhance communication and development of collective problem solving mechanisms

Raise cluster profile and build up the collective identity

Encourage development of collective learning capabilities

- **Factors related to a cluster's continued development**

Conduct cluster evaluation and launch re-alignment programmes

Adapt to avoid technology discontinuities and avoid lock-in

Improve regulatory regime in accordance with new technology development

Commit to long term cluster development

Step up support effort to meet the needs of cluster enlargement

Explore additional/complementary resources (technology and actors)

Strengthen governance and stimulate further dynamism

#### 6.3.3.2 The role of government in cluster building process

**1. Rationales for government intervention**

There are numerous debates about whether a government should intervene in cluster development. It has been argued that the world's most successful high technology cluster in Silicon Valley developed naturally, thus making government intervention unnecessary. However, proponents of the innovation system approach insist that the role of institutions, in particular the government, is of high importance to cluster development. The author of this thesis tends to support the latter notion. Given that most regions do not possess all the necessary factors or conditions for developing a high-tech cluster, the government has a role in helping to create favourable conditions that are crucial for cluster building.

As the cases of Scotland and Hong Kong showed, their diverse nature and differences in the level of success are by and large the results of different government policies. If governments are clear about why they have to intervene, they can play a more proactive role in directing the cluser building process and fend off criticism. The rationales for government intervention in cluster building are summarised below:

1. Private initiatives alone are not enough to constitute a cluster. Governments are better able to pursue a long term cluster vision and foster an environment that encourages cluster development.
2. Technology development is becoming more complex and simply using the 'technology push' approach is no longer enough. Government has a role in pushing a 'demand pull' approach by playing the role of a user/buyer of technologies, as well as using indirect

instruments to stimulate demand, such as the promotion, the diffusion and adoption of a particular technology

3. A region may not have all the technology and social constituents for cluster development. Governments are in a better position to develop national and international networks to obtain resources and capabilities which may contribute to a particular technological innovation beyond the regional level.
4. When coming across problems during the cluster building process governments are in a better position to mediate and facilitate problem solving.
5. Distinct from technology forcing (or winner picking), cluster building is very much an evolutionary process which focuses on learning processes and adaptive behaviour. Governments can encourage institutional or regional learning and help translate individual learning into collective knowledge.

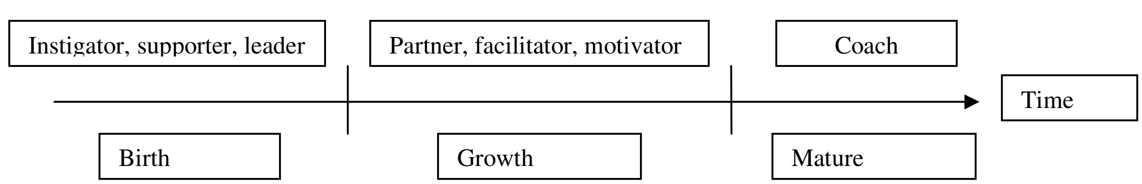
**2. Different roles of government along the stage of cluster development**

The evolutionary nature of cluster development also implies that cluster promoters have changing roles along the path of cluster building. The roles of a government at different stages of cluster development include the following:

1. instigator, supporter, leader
2. partner, facilitator, motivator
3. coach

It should be noted that a government may perform all these roles simultaneously, but the relative importance of each role varies at different phases of the cluster development. Figure 6.4 shows the different roles of a government along the timeline of a cluster's growth and evolution.

Figure 6.4 Different roles played by governments during different stages of cluster development



**a. Time 1—The roles as an instigator, supporter and leader**

**The role as an instigator**

The birth of clusters involves simultaneous systemic advancement of a large number of factors. Private initiatives may not be enough to instigate a large-scale constituency building process and this gives governments an instrumental role to kick start the process of cluster building. As part of the actual constituency building process, a government can proactively commission study reports and send signals to industry and the wider society about the importance of innovation and technology. The aim is to align the mindsets of the potential stakeholders to the cluster strategy, thus helping make the transition from idea to action easier. Being an instigator, the government also has to encourage the stakeholders to take part. To engage prime movers to join the constituency building process is always difficult. The government has to make an extra effort to persuade individual companies, in particular the market leaders, to take part, sometimes by providing tangible benefits or financial incentives (like an incentive package was given by the Scottish government to Cadence). Once the prime movers are recruited, it is easier to encourage other actors to engage in the constituency and the cluster building process can advance.

**The role as a supporter (physical needs)**

Apart from being the instigator, government also plays a role as a supporter of the cluster. The government support the birth of the cluster by providing a wide range of infrastructural resources and making use of effective policy instruments to create a favourable institutional framework, which include the following:

- Investing in the physical (land and premises), institutional and technological infrastructures
- Using regulatory power to foster an environment conducive to technology development
- Designing and setting priorities for initial implementation of cluster policies
- Providing incentives and financial support when needed
- Coordinating with different government departments and non-governmental organisations

**The role as a leader (psychological needs)**

At the birth stage a government may take the lead in the cluster building process. The importance of a government being a leader of a cluster is not only about the provision of tangible resources and a suitable environment, but also involves the government's ability to provide leadership to influence the perceptions and motivations of actors. The first role of a leader is to identify the vision and goals of the cluster. A vision not only gives justification to the existence of a cluster, but also helps link up different actors which make up a cluster, who have to be united to work together towards a shared vision. Besides, a leader helps bring the best of out of the actors in the cluster through the following:

a. Managing: to discover the competencies of each actor, to strengthen them and to identify their complementarities with each other.
b. Teaching: to teach the actors the importance of innovation and networking, letting them learn how to act appropriately within their own organisations and also at the inter-organisation level
c. Being a role model: to demonstrate the best practice for innovation and networking, and showing its long term commitment to technology development, which will encourage other actors to follow the government's example.

Being a leader of a cluster the government has to understand the strengths and weaknesses of each actor and to appreciate what they want from the cluster. To achieve this the government also should have an impartial attitude towards all actors, regardless of their size and ownership, as well as a belief that big and small organisations can contribute something to the cluster.

**b. Time 2—The roles as partner, facilitator and motivator**

**The growing role of the industry**

While a government plays an essential role at the birth stage of the cluster development, it does not mean that building a cluster is the sole responsibility of the government. In fact, the government can never build the cluster for companies. When the cluster begins to grow the government has to give responsibility for cluster building back to companies and then take a subsidiary role. Every company is a small cluster itself with its own demand and supply networks, formal and informal networks with government, PSR, and other supporting institutions. If every company takes responsibility for strengthening the networks within their small constituency at the intra and inter-organisational levels, and play its part in managing, teaching and acting as a role model within its own constituency, this build up of networks will allow a small cluster to become a mega cluster. To achieve this, organisations within the cluster should be willing to change themselves through innovation networking and cooperating with each other in technology development. Usually, government incentives can only be a short-term, superficial solution. Only when most of the actors have changed their perceptions, by internalising innovation and networking practices can the constituency building process proceed to another stage.

At the growth stage, when the cluster accumulates sufficient momentum, the government can gradually allow the private sector to take the leading role. At this stage, the role of the government and the private sector are of equal importance. They are partners. While the private sector begins to take the lead in some aspects, the government still plays a role as a facilitator, or an intermediary, to encourage development. Besides, the government also has an important role as a motivator when the cluster encounters difficulties. The government works with the private sector to overcome obstacles in these circumstances.

**The role as a facilitator**

One of the main roles of a government in the growth stage is to faciliate the development of networks among different actors in the cluster. With an understanding of the commerical interests, capabilities and knowledge requirements of the actors, a government can help define the common interests, goals and complementary assets of different actors in the cluster. Besides, a government can improve the interface mechanism of different organisations by acting as an intermediary. Being a middle-man, a government can help enhance the trust among different actors, thus contributing to the development of collaborative relationships. For instance, a government can help bridge the cultural divide between industry and academics by providing communication channels between them. The government can also develop a database to identify the research interests and complementary aspects of their knowledge. A constant review and update of information can improve the understanding of each party’s needs. In addition, the government can help build networks with actors who are not yet involved in the cluster but may become important actors in future. Since these target actors may be located outside the existing cluster or regional boundary, the government is in a better position to initiate these kinds of cross-sector or cross-country networks which require different forms of participation.

**The role as a partner**

At the birth stage cluster policies are a bit similar to the old style ‘winner picking’ approach as the government is almost in charge of everything. However, at the growth stage cluster policies should shift from a pure ‘top down’ approach to a ‘public-private partnerhsip’. A public- private partnerhsip approach gives at least three benefits; first, as Freeman and Soete (2000) point out, private firms are better at idenfying growing technology markets and supplying innovative products to these markets; second, cluster development involves the investment of huge resources, so cooperating with the private sector in cluster initiatives, such as technology foresight exercise or seed capital provision, can help reduce the government’s financial burden and reduce risks in technology development; finally, both the government and the private sector can learn from each other through the interactive learning process. Through this, the government can have a better understanding of the private sector’s needs whilst the private sector can learn from government’s practices, thus improving the overall design and implementation of the cluster policies.

**The role as a motivator**

At this stage, even though the cluster has already built up the momentum to grow there may be unexpected obstacles that hinder the development of the cluster. In the face of such events, some actors, who are looking for short-term financial gains, may want to revert to their old practices. When this happens, the government has a role to assist the private sector to overcome the difficulties and help re-align the different elements in the cluster. Of course, the overcoming of difficulties will be above all the responsibility of each private actor, and not everyone will succeed, but the government can certainly play a role. The following two situations will demand the ‘motivator’ role of government.

**i. mis-alignment between target and commitment**

The role of a government is to understand the causes of the problems and identify the solutions. If the problem is caused by a failure to meet a cluster’s target so that cluster stakeholders may want to withdraw their commitment to technology development, the government should try to help them to maintain their commitment by taking measures that demonstrate the government determination in the face of temporary setbacks. The government must also remind them that the achievement of the cluster vision can bring long-term collective benefits. Thus, to realise their ultimate goal, cluster stakeholders they must keep going even in difficult times, even because they can re-align the form of their participation. The government should also reaffirm its long term commitment to technology development and give appropriate incentives to boost the cluster stakeholder's interests and confidence in the cluster policies.

**ii. mis-alignment between target and competence**

If there are difficulties caused by the inability of the cluster actors to meet the pre-set targets, the government can investigate the reasons for this. The problem may be twofold: first, the cluster target may be too ambitious or simply unrealistic for the cluster stakeholders to achieve; second, the cluster stakeholders may not have sufficient technological competence to realise the target. These may be obviously interrelated, but with the former the government should re-define and realign the target. With the latter the government should recognise the limitation of the cluster stakeholders' technological competence and look for ways to overcome them.

As the cases of Scotland and Hong Kong showed, failing to meet the cluster targets does not mean that the two regions' cluster policies are complete failures. Rather than focusing on the failures, the government can remind the actors of the value of what they have done, what they have achieved, and explain to them the meaning of their actions, and the lessons they can learn from the problems. Moreover, government should encourage actors to persevere and be more patient in endeavouring for the results to come.

**c. Time 3—the role as a coach**

At the mature stage the industry should have taken over the leadership role of the cluster. The government now takes a subsidiary role, mainly in helping the cluster stakeholders to learn from each other and in identifying future opportunities.

**The role as a coach**

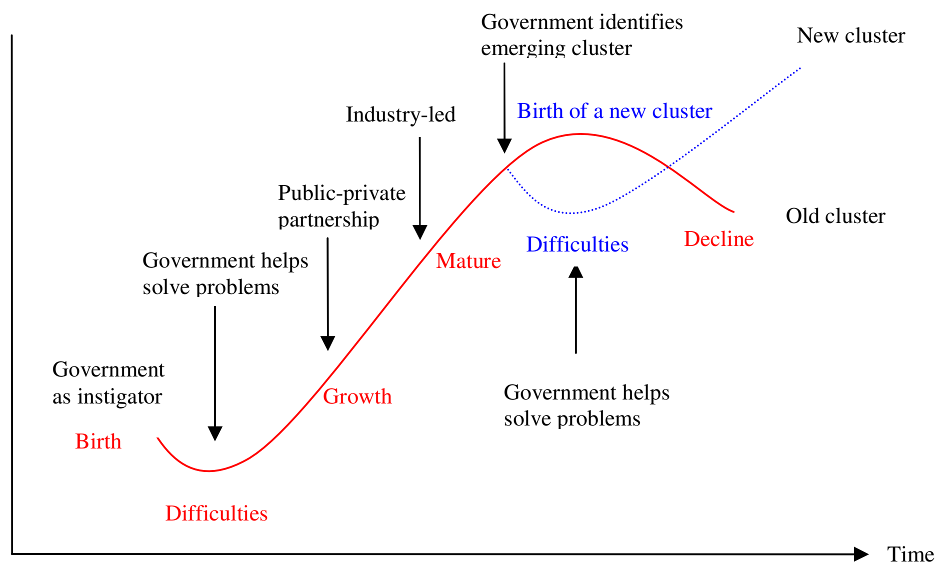
At this stage the development of the cluster is fairly stable. In spite of this the government still has to keep monitoring the operation and the evolution of the cluster. The continuous growth of a cluster does not rely on one or two big companies, but all the cluster stakeholders evolving together in the desired direction. This gives the government a role to encourage cluster stakeholders to develop a learning capability, which enables them to review and check if the cluster constituents are advancing in the desired direction and at the desired pace. In order to develop such a learning capability the government should encourage open communication among all cluster stakeholders. In particular, the government can provide channels or platforms for actors to communicate honestly and constructively, instead of negatively criticising each other. Feedback is very important for understanding what has gone wrong in a cluster. It enables actors to learn from each other's mistakes and effectively solve the problems with their improved knowledge.

The government also has a role in monitoring the change of the external environment. Sometimes the shift of the technology trajectory may render the existing technological competence of the cluster obsolete. To prevent this, the government has a role to map the changes, both in the external environment and within the cluster, and to identify the new threats and opportunities in association with the shift of the technological trajectory and the external environment. When there is a need for an overall transformation of the technology regime the government has to facilitate this by building a new cluster, including the articulation of new goals and introduction of new strategies.

To prepare for the shift of the technological trajectory a government can support basic research and pre-competitive R&D, which is usually troubled by a lack of investment from the private sector. Under pressure to make a profit, industry may take a myopic view of the value of developing radical/alternative technologies because they take time to mature and to generate commercial benefits. However, the government is in a better position to invest in these 'market failures' and support the development of these new technologies. Though some scholars argue that a government can hardly decide which is the 'right' technology to support, given the relative distance of the government from technology development, industry, with a better understanding of the technology possibilities, can assist the government in this process by participating in technology foresight or appraisal exercises. In other words, industry can help the government in picking the appropriate technology. As the government prepares for the potential shift of the technological trajectory it can draw a scenario of their possible development outcomes, which include pushing forward a systemic change, developing complementary assets and facilitating institutional change. By subsidising basic research and the development of pre-competitive technology, the government can play a part in identifying and shaping the path for the new technology cluster.

Figure 6.5 is a graphical illustration of the roles of government at different stages of successful cluster development. In short, the government plays the most important role in the birth phase, acting as an instigator, supporter and leader for the cluster. The role of the government becomes less important in the growth phase. During this phase momentum has been built up and the cluster development process is by and large autonomous. The government only intervenes when problems occur and seeks to re-align some non-aligned elements. Finally, when the cluster is at a mature stage, the industry takes the leadership role of the cluster whilst the government plays a subsidiary role. The government fills the gap left by the 'market failures' and helps prepare for the decline of the old cluster. When a completely new technological trajectory emerges, the government plays a directive role in building a new cluster and the process of cluster building starts all over again.

Figure 6.5 The role of government during various stages of the evolution of a technology cluster



## 6.4 Some reflections on the literature

This section aims at comparing the research finding with respect to the literature reviewed in Chapter 2. The similarities and differences between them are outlined as below:

### 6.4.1 Similarities between the research finding and the cluster literature

#### a. The essential conditions for cluster development

First of all, the Scottish and Hong Kong cases supported Molina's (1990, 1993) notion that cluster building process is deeply conditioned by its contextual environment. The research findings also confirmed that the following contextual elements, as highlighted by various cluster theorists are of high importance to the success of the cluster building process. They are:

- Historical incidents and economic structures which lead to specialisation of industries and lock-in effects (Krugman; 1991; Lundvall, 1992; Molina, 1993)
- A critical mass of key organisations with complementary resources/competence which provide the infrastructure and institutional support for innovation (Amin and Thrift, 1996; Porter, 1990; Lundvall, 1992, Cooke, 1997; Carlsson and Stankiewicz, 2000; Breschi and Malerba, 2000; Molina, 1993)
- Networks among these key organisations to facilitate knowledge exchange and organisational learning (Porter, 1990, Lundvall, 1992, Cooke, 1997; Carlsson and Stankiewicz, 2000; Breschi and Malerba, 2000; Molina, 1993)
- A culture or milieu encourages communication, reduces uncertainty and generates trust (Grabher, 1993; Perrin, 1988; Saxenian, 1994; Cooke, 1997)

The research findings validated that all these elements set the initial conditions for the constituency building process and have crucial impacts on the cluster policy design, implementation and evolution at the later stages of the cluster development, as pointed out by Molina (1990; 1993).

#### b. The origin and growth of a cluster

Not many cluster theories have addressed the origins of a cluster except the theories of Porter's cluster (1990), Molina's sociotechnical constituency (1993) and Carlsson and

Stankiewicz's technological system (2000). They all regard the origin of a cluster as problem-driven. The empirical research proved that the building of the Scottish and Hong Kong ICT clusters were triggered by their respective problems, in particular the erosion of competitiveness of the two regions' traditional ICT industries due to fierce competition from other countries, which compelled the two governments to take actions to solve their economic troubles. Besides, the 10 year longitudinal studies of the two ICT clusters also revealed the growing nature of the cluster building process, as suggested by Carlsson and Stankiewicz (2000). The two cases showed that by the end of the research period, the actors involved in the two clusters had increased, for instance, in terms of the cluster supporting policy programmes as well as in the geographical space of the two clusters. As a result of the enlargement of the two clusters, more new actors and resources should continue to join the constituency-building process in order to sustain their continuous development.

#### c. The diversity of a cluster's development

The diversity of the Scottish and Hong Kong ICT clusters proved that no cluster is the same. This also explains why there are so many different cluster theories. As said in Chapter 2, scholars studying clusters at different levels, focused on different industries, or at different stages of a cluster's development might come to different conclusions about a cluster's nature and characteristics. Besides, the empirical cases revealed that, despite the application of very similar cluster strategy, the implementation of the policy programmes, as well as the governance of clusters and the external environment may affect the cluster's development and lead to very different evolution processes and results. For example, the Scottish cluster grew to embrace more ICT industries, whilst the Hong Kong ICT cluster expanded its geographical boundaries. The diversity of clusters' nature and evolutionary processes implies that policy makers who seek to build clusters must not apply a standard cluster policy programme, but have to tailor the cluster policies to meet their countries' needs, building on the realistic understanding of their own contextual environment and issues.

### 6.4.2 The differences between the research finding and the literature

#### a. The evolutionary nature of the cluster building process

Most cluster theories such as Porter's (1990) cluster theory tend to view a cluster as rather static over time. This is due to the fact that much cluster research has been based on a snapshot approach that merely focuses on studying the cluster at a specific period of time. In contrast to the static view of a cluster, the research findings confirmed that a cluster is in a constant evolutionary process that can be divided into a number of stages, including birth, growth, development and evolution. The concept of seeing a cluster as having different stages is similar to the theory of a technology life cycle proposed by Utterback and Abernathy (1975). These authors regard technology development as consisting of a number of different stages and each has its own special nature and characteristics. While the cluster building process itself has been ignored by many researchers, the research finding suggested that the cluster building process can be conceptualised into a deliberate problem solving activity which involves the processes of 1) knowledge/variety creation; 2) routine creation/ transformation and 3) policies and actions selection. The learning accumulated along the cluster development path can help solve the problems through processes of alignment and re-alignment and eventually re-shape both the cluster and the contextual environment. The insights drawn from the two case studies with regard to the evolving cluster building process are also in line with the evolutionary economic theories (Nelson and Winter, 1974; Dosi and Nelson, 1994) and the sociotechnical constituency approach developed by Molina (1990; 1993)

### b. The neglected social constituents in a cluster

As mentioned before, most cluster theories, such as Porter's (1990) cluster theory and Lundvall's (1992) NSI theory identified a number of structural elements that must exist in a cluster. Therefore, when governments attempted to build a cluster, they tended to focus on creating the 'factor conditions' (Porter, 1990) or 'R&D organisations' (Lundvall, 1992) and other technical constituents (Molina, 1990; 1993) of a cluster. However, the 'social constituents' in a cluster have always been neglected, even though their importance has been highlighted by Molina (1990, 1993) in his sociotechnical constituency approach. The case studies showed that the ICT clusters in Scotland and Hong Kong were fraught with difficulties due to their governments' ignorance regarding the cognitive dimension of these social constituents including the vision, perception and motivation of the actors who are determinant to a cluster's level of alignment and sustainability. Besides, the cultural dimensions of a cluster - such as a learning culture and associative relationships and innovative milieu which have been emphasised by scholars including Cooke (1997), Storper (1995) and Saxenian (1994) as crucial for achieving informal cluster governance - have been also ignored by policy makers in the two regions, especially in Scotland. This may be due to the fact that these social and cultural factors are difficult to create through a policy process and yet the literature has not discussed about how to create these factors in the first place in case they are absent in a region/country.

#### c. Over-simplicity of cluster theories and the real life management difficulties

Most cluster theories tend to offer a simple explanation to the cluster phenomenon and the generation of cluster dynamics. For example, Porter's (1990) theory indentified the five 'diamond' factor conditions, Lundvall's (1992) NSI theory emphasised the essential institutions and the learning process through networks, etc. Despite the high relevance these factors and dynamics for cluster development, the empirical research showed that the presence of these factors is by no mean guarantee that a cluster can be built successfully. As mentioned before, a cluster building process involves multi-actors, takes place in multi-domains and at multi-levels. Also, a cluster's environment will keep changing over time and is subject to constant external influence. If a government designs a policy programme as if its cluster is developed in a close environment, it is very likely that such plan will come across numerous difficulties when facing the complex reality. In fact, the research findings showed that cluster building is a long term process and, over time, there is a greater opportunity for uncontrollable circumstances to affect the government's best laid plans (like unpredicted economic and industrial downturn). Due to the complication of a cluster's building process, it is impossible for a government to control all the factors beforehand. Therefore, the government should better focus on managing the cluster 'process' and seeking alignment of various dimensions in the cluster building process, instead of seeking the creation of 'factor conditions' alone. The research findings challenge the uncritical application of standard cluster policies to every country, as there is no single 'best practice' for cluster building but a lot of 'learning by doing' along the way.

#### d. Over-emphasis on top-down governance, less attention to bottom-up governance

The two case studies re-confirmed the important role of government in a cluster, which is consistent with most of the cluster theories such as Porter's (1990) cluster theory and Lundvall's (1992) NSI theory. However, these theories tend to stress the crucial top-down governance, while not many of them address the crucial bottom-up governance, except in Cooke's (1997) RSI and Molina's (1990; 1993) STC theories. Since policy-makers in

Scotland and Hong-Kong were influenced by top-down approaches, their processes of cluster-building tended to follow this approach without much attention to a bottom-up approach. However, the research findings suggested success in cluster building is unlikely to be achieved, unless the cluster actors are willing to change their perceptions and align their goals and actions with the cluster strategy. The cases of Scotland and Hong Kong also demonstrated that the application of a top-down approach in cluster-building tend to create problems, as the cluster actors' perceptions and goals might not be in alignment with the government's. In addition, using a top down approach to demand a change of the old routines also tends to cause disruption and resistance. In view of the above, governments might find that they derive important benefits by using a bottom up approach to cluster building. In particular, the cases of Scotland and Hong Kong highlighted the importance of motivating the actors by using cost and benefit conditions. The cases showed that many companies chose their specific location due to the benefits they gained from the location, such as financial incentives, lower rental or labour costs or high quality intellectual properties. Public policy seeking to promote the development of clusters may consider the usefulness of integrating their policy instruments with the interests of the actors. Besides, another cost-effective bottom-up approach to motivate the actors is the use of network organisations, as Cooke (1997) suggested. In short, for cluster policies to improve their effectiveness, policy makers should be mindful of the goals and perceptions of the cluster's actors, paying close attention to ways and means to motivate them to take appropriate actions to uphold the cluster-building activities.

**e. Over exaggerated accounts regarding the influence of a cluster**

The cluster theories tended to emphasise the significant impacts of a cluster on a nation or region. For example, Porter (1990) linked cluster to the competitive advantage of nations, Lundvall's (1992) NSI and Cooke's (1997) RSI theories also highlighted the role of a cluster in promoting innovation and economic re-generation of a country/region. As a result, many policy makers in the world place high hopes on cluster strategies and believe that it can make a sea change to their technological capabilities or solve their long standing economic problems. However, the two empirical cases showed, when viewing a cluster in a long-term perspective, that the impact of a cluster on the economy or employment can be very small, even though the ICT clusters in Scotland and Hong Kong have developed for ten years. Sometimes the impact of a cluster has been over-exaggerated in the literature. Although the the research findings do not deny the potential influence of a cluster, a policy maker should be aware that the impact of a cluster strategy may take a very long time to materialise. The implication is straightforward: when a government decides to build a cluster, it should set targets and timetable in more realistic terms, so as to avoid disappointment and the lost of support from the general public.

### 6.5 Chapter summary

Section 1 of this chapter outlined the similarities of the ICT cluster building processes in Scotland and Hong Kong. At the cluster level the two clusters had similar origins since both were driven by problems. They also went through similar steps in building up the constituencies for their clusters. Meanwhile, similar problems, including the worldwide economic recession and the global ICT downturn, caused serious problems. The two clusters have not achieved the results as planned, but the two governments learnt from their setbacks and initiated a series of re-alignment programmes to solve the problems.

Section 2 aimed at highlighting the heterogeneity of the ICT cluster building processes in Scotland and Hong Kong. The two regions applied different approaches and used different instruments to build their ICT clusters. When facing difficulties the two governments responded differently. The Scottish government strengthened its commitment to technology development whilst the Hong Kong government shifted its policy to support the service industries. Moreover, the evolution processes of the two ICT clusters were heading in different directions. The ICT cluster of Scotland has gradually developed from a single technology-based cluster to a regional innovation system. Conversely, the ICT cluster of Hong Kong started as a regional innovation system without specific technology targets, but later a technology focus gradually emerged and transformed it into a technology-based cluster. By the end of the research period the Scottish ICT cluster seemed to have a better alignment conditions than its Hong Kong counterpart.

The objective of Section 3 was to draw out the common good practices for building clusters. It shed light on the general nature of the cluster building process, which was a complex process involving multi-actors, multi-levels and multi-factors. The long-term evolutionary nature and learning process of cluster development also deserved special attention. Besides, the case studies revealed the importance of the psychological aspects of the cluster actors. The alignment of the actors' perceptions to the cluster's goals was crucial to cluster development. The case studies also highlighted the equal importance of cluster policy design and implementation. In particular, the learning generated during the implementation process could be of use to improve the cluster building process. Finally, the divergence of the cluster-building processes in the two regions implied that governments should take into account their specific technological and institutional contexts when designing cluster policies, instead of imposing a standard formula.

Section 3 also summarised the cluster building process into ten steps and outlined the key issues in each of them. A taxonomy of factors contributing to successful cluster building was proposed for use as a brief checklist for planning a cluster and assessing its development. The changing roles of a government along the path of cluster evolution were explained in this section. Government played the most important role at the birth stage, but then it gradually allowed the leadership role to move to the private sector as the cluster grew and matured. When the old cluster began to decline and a new one emerged the government resumed its leading role.

Section 4 compared the research finding to the literature reviewed in the previous chapters. The two empirical cases confirmed a number of key points already made by the literature, including several essential conditions for cluster development, the problem-driven origins and expansion of a cluster, as well as the diversity of clusters' nature and characteristics. The research findings also refuted the static aspects of cluster theories and emphasised an evolving cluster process consisting of different stages and dynamics. The findings also challenged the literature which tended to neglect the social constituents of the cluster, and the difficulties of implementing the cluster strategy. It is advisable for governments seeking to build clusters to motivate the actors by using a bottom up approach and setting up realistic visions and goals.

# Chapter 7 Conclusions and implications

**Objectives: To answer the research questions, summarise the implications and make recommendations for further research**



## 7. Introduction

This chapter serves as a conclusion to the whole thesis and seeks to summarise the findings related to its research problem. Sections 7.1 and 7.2 answer each question set in Chapter 1 and also the general problem of research. Implications for cluster theory, public policy makers and private sector managers are drawn out in Section 7.3 and 7.4, with the aim of advancing cluster understanding and making the insights derived from this research applicable to the real life context. Section 7.5 is concerned with the limitations of this research and Section 7.6 highlights some prospects for further research based on the findings of this thesis. The thesis ends with a brief chapter summary outlined in Section 7.7.

## 7.1 Conclusions about each research question

The main theme of this thesis is to study **how an industrial cluster can be built by policy design and what processes are involved in cluster building**. Four research questions have been formulated in an attempt to tackle this research problem. This section provides answers for each research question, based on the findings from the empirical study.

### 7.1.1 Answers to the 1st research question

**Q1. What is the nature of the processes involved in the purposive attempts to create clusters?**

**a. complexity of cluster building process**

The thesis revealed that cluster building, as a means to foster technology development, is a highly complicated process. It involves technological and social changes taking place at <u>multi-domains</u> (technology, finance, marketing, and training in an organisation), <u>multi-levels</u> (e.g., project, cluster and regional industrial) and among <u>multi-actors</u> (diversity of actors and intermediaries). Moreover, <u>multi-factors</u> affect the process, including the institutional set up of the innovation system, the nature and maturity of the technology, competitive or cooperative culture of the region, the dynamic generated by the coupling technology push with market demand, and the development of interactive learning relationships (both formal and informal) among different actors. This challenges the cluster policies of many countries that make simple assumptions about how a cluster can be built, and hence calls for a wider set of policies to support various areas and dimensions of clusters.

**b. context conditioned process**

The IC and NSI approaches clearly showed the importance of structural characteristics to the cluster building process. The empirical study also confirmed that the cluster building process is deeply conditioned by contextual characteristics of the region, in particular the innovation system in which the technological process occur. These contextual characteristics indeed act as the starting conditions of cluster-building processes. For instance, the strength of the science base conditioned the availability of STI for industrial innovation, the extent of the formal and informal networks limited the possibility for knowledge transfer and interactive learning amongst actors. Moreover, whether a region can capitalise on the opportunities derived from an emerging technology depends on the technological capabilities of the firms existing in the region. If a region has a favourable contextual condition it is more likely that a successful cluster can be developed, and that the government will not have to invest greatly to rectify the structural environment. On the contrary, if a region does not possess the necessary conditions, a government intending to build a cluster has to prepare for heavier investment and larger scale intervention policies to compensate for the contextual weaknesses.

**c. purposive and socially shaped process**

The empirical case study revealed that cluster building is a purposive activity. The cluster builders set a vision for the cluster and mobilise the actors to take part in supporting the achievement of this target. The benefits associated with the ultimate vision become essential 'drivers' in motivating the actors to take part in the collective action of cluster building. The study also confirmed the insights from sociological studies suggesting that cluster building is, by and large, a social process. In particular the concepts of 'social construction of technology', 'actor network theory' and 'evolution of technological system' are of relevance to the cluster building process. However, due to the diverse interests, goals and perceptions of the actors, they may exhibit many different behaviours which generate difficulties in managing the cluster building process. Therefore, policies for cluster building must be flexible enough to incorporate different incentive mechanisms and use a wider range of instruments to meet the different needs of these actors.

**d. evolutionary nature**

This thesis challenges the simple linear model of innovation and technology development. Much research assumes that technology is given and the technological process is stable over time. However, this thesis, through a ten year longitudinal mapping of the development of two clusters, showed that the innovation process, industrial structure of the region, the goals and perception of the actors, as well as network characteristics among them, have changed over time and are still changing. This insight from the evolutionary nature calls for a change of policy focus and governance mode along the different stages of the cluster development. It is also advised that the government should monitor the cluster regularly so as to avoid the technology targets and supporting policies becoming obsolete.

**e. co-evolution between actor and structure**

Whilst cluster building was deeply conditioned by contextual factors, this thesis also showed that the endogenous force of the actors can influence the structural conditions. In particular the perception, goal and motivation of actors, if positively aligned to the goals of a cluster, can contribute to the development of technological capabilities in driving the process of technological change. The actors contribute to the generation of variation and their selection process help shape the direction of the technology development, leading ultimately to a transformation of the innovation and production systems. This implies that cluster policies should not focus narrowly on technology and economic aspects, but also take into account the broader social elements, including the perceptions, goals and interests of these social actors, as well as the interaction and networks amongst them, which are crucial for enhancing cluster development and technological change.

### 7.1.2 Answers to the 2nd research question

**Q2. How are cluster's visions, strategies and policies created and implemented?**

**a. creation of vision**

This question aims at exploring the actual steps involved in building a technology cluster. The cluster building process has been conceptualised into a constituency building process in which separate constituents, both technical and social, evolved into a collective programme of building technological capabilities. In this purposive process, vision setting has been one of the most important elements, as it helps unite the actors by aligning their goals and perceptions with the vision of the cluster. It is suggested that a vision representing a wider societal benefit, such as economic improvement, competitiveness building or employment enhancement, may help satisfy the interests of a wide range of actors in the cluster.

The vision, showing the realisation of the constituency building programme, is sometimes driven by ‘problems’. Both empirical cases showed that their cluster building processes were triggered by the erosion of their national competitiveness. The visions set by the two governments represented the end state of their cluster building efforts—the building of competitive advantage through stronger technological capabilities.

**b. designing strategies**

The strategies are paths to realise the vision, which involve cluster actors utilising their problem solving capabilities either to tackle their structural problems or to build up technological capabilities. The governments may identify the appropriate strategies for themselves by drawing a link between their present state (problems) and end state (problems being solved) as set in the vision, and then outline the steps to reach their solutions. The design of strategies is not an easy task. In particular when building a knowledge-based cluster, a large number of areas may have to be influenced and transformed, which necessitates a systemic or holistic strategy to work on a wide range of policy areas. Besides, the government has to pay attention to aligning the actors' goals and perceptions to the chosen strategy. This process always involves negotiation and consensus building, and communication among different parties is the key for designing an appropriate strategy which is supported by the actors at large.

**c. policy implementation**

The policy process is crucial for transforming the existing system into a new cluster. Since conflict of interests amongst actors seems unavoidable, policy processes are an essential element in uniting their diverse goals and perceptions during the cluster building process. On one hand, policies represent an outcome of consensus building; on the other hand, policies can help generate consensus since the legitimisation process can enhance the public's acceptability of the cluster. The process of cluster building involves the translation of cluster strategy into different government initiatives and policy programmes to support actors in building their technological capabilities. To design policies which can effectively build a cluster, a government has to understand what the actors want from the cluster in the first place and design policies to meet their specific needs. This also helps align the goals and perceptions of the actors to the goals of the cluster. When designing the policies a government should pay attention to the wider context for cluster development. Simply by addressing what is missed (or market failure) is not enough. A visionary government should pay attention to the growing prospects for the cluster and plan new policies to meet its future needs, such as launching new programmes and initiatives at different stages and recruiting new target actors and resources from other regions.

### 7.1.3 Answers to the 3rd research question

**Q3. What factors and difficulties influence or affect the translation of cluster visions and strategies into practice?**

**a. mis-alignments of the STC diamond**

The complex nature of cluster building implies that there is a large number of factors involved in the cluster building process and it is impossible for cluster builders to control all of them. In fact any of these factors may go wrong and cause different problems for the cluster. The socio-technical constituency diamond highlights a few problem areas which call for special attention from the cluster builders. For instance, technology development itself is a highly uncertain process, which is susceptible to the influences of the trajectory shift and regime change. The life cycle of a technology can easily make a technology policy obsolete and unfit for the current technology trend. Besides, whilst the success of a cluster building process depends on the alignment of the goals and perceptions of the actors with the cluster's goal and vision, human factors are the most difficult element to manage. Actors' interests and beliefs may change for reasons beyond the control of a government and cause serious mis-alignment in the constituency of the cluster. Moreover, the problems related to governance issues may undermine the cluster building process. As the cases of Scotland and Hong Kong showed, actors' enthusiasm about technology development may weaken due to scandals in the cluster management team or because of perceived mis-management of the cluster programmes. Other problems highlighted by the STC diamond including competition from other overseas clusters and other technology sectors, as well as failure to include the necessary actors and resources to support the expansion and growth of the cluster. Many of these factors may seem trivial at the first glance, but will have serious consequences for the cluster building process, and perhaps result in the dissolution of the constituency.

**b. difficulties of changing perceptions**

In addition to the above, cluster actors come from different organisations and have different interest, routines and cultures, so that uniting them into one constituency to achieve a specific goal is extremely difficult. To a certain extent cluster building requires a whole new mentality with respect of innovation, technological collaboration, networking, knowledge sharing and collective learning. Even the government has to adopt new policy thinking, such as designing a holistic policy framework, long-range development processes, public-private partnerships, and negotiation and consensus building. Encouraging a change in thinking may take a very long time, and the government may use different instruments, such as incentives and promotion campaigns to help change in the actors' mind. The government should also avoid trying to use an exclusively 'top down' approach to change thinking patterns as it may cause too much disruption and lead to opposition from the actors.

**d. uncertainties and luck**

Nevertheless, the problem stated above may be potentially solved by the government with proper management. Yet some cluster problems are unexpected. For the cases of Scotland and Hong Kong, their cluster building effort were seriously hampered by a number of incidents, like the 9/11 incident, the Asian financial crisis and the outbreak of SARS. This implies that uncertainty is an intrinsic part of the cluster building process and that luck is a factor that can determine a cluster's chance of success. Though many problems may seem unavoidable, the government can constantly monitor the cluster, in particular by paying attention to the mis-alignment of different elements highlighted by the socio-technical constituency diamond. By developing sensitivity to the changing interests and perceptions of actors, as well as the external environment of the cluster, a government can detect potential problems and tackle them at an early stage.

### 7.1.4 Answers to the 4th research question

**Q.4 Can a general good practice be identified for policy processes in different regions or countries?**

**a. heterogeneity of cluster building process**

As demonstrated in the two case studies, the building process of a cluster is deeply conditioned by the contextual environment in which it locates. This explains why a national innovation system has a profound impact on a country's technological capabilities. Every nation has its special characteristics and culture, and the idiosyncratic nature of the cluster building process implies that it is difficult to copy the successful experience of other countries. The particular set of factors contributing to the success of Silicon Valley, may not combine with the same success in other countries, because local features will not be the same, and likewise with the actors involved and the wider external environment. Hence, the dynamics generated under a special circumstance cannot be reproduced elsewhere. It is suggested that government should not simply copy the cluster policies from other regions, but should pay attention to the contextual characteristics and adapt cluster policies to meet the needs of their own region. Nevertheless, the experiences of a region can be a valuable guide for other countries. The insights from the cases of Scotland and Hong Kong can inspire them to develop the 'best practice' for building their clusters.

**b. importance of building technological capability of firms**

This thesis conceptualised the cluster building process into the technological capability building process. The insights from innovation studies can be of use to governments seeking to design cluster policies to support the development of technological capabilities. The complexity of the technology development process implies that cluster building should adopt a holistic/systemic approach and take into account a whole range of conditions and contributing factors for technology development. Government should also seek to support 'learning' within and between companies and the PSR. By encouraging companies to involve in innovation activities they can achieve 'learning-by-doing' and enhance their 'absorptive capacity'. A government can achieve this by persuading a few market leaders in the cluster community to take a lead in innovation, and then other actors may follow suit. Besides, a government can also help companies to learn-by-using and -interacting through facilitating the development of networks amongst them. A critical mass is crucial for generating synergies and momentum for technological capability building. A government should pay attention to foster the growth of indigenous sectors. Building up of technological capabilities will not happen very quickly and government should adopt a very long term approach and have a consistent commitment when developing clusters.

**c. importance of aligning the perception of actors**

This thesis highlights the importance of the perception of actors and points outs that one of the keys for successful implementation of cluster strategy is to change actors' perception to encourage them to continually innovate over a long period. However, since most actors are from different organisations, and under the influence of different routines and cultures, they may find it difficult to allow their interests to align with the goals and actions of the cluster policies. When facing this situation a government has to educate the actors about the importance of technology development to a country's competitiveness, and to induce a positive response from the actors, by using different incentives to motivate them. To avoid causing too much disruption a government may introduce changes in a step-like manner. This helps actors to shift their perception gradually. Besides, government can collect feedback from the actors on a regular basis to understand their perception of the cluster policies.

**d. calling for a flexible approach**

This thesis emphasises the importance of managing the cluster building process instead of simply focusing on creating favourable 'factor conditions'. Given that cluster builders are unable to avoid contingency and setbacks during the cluster building process, they should keep their approach open and flexible. It is recommended that instead of trying to design a 'perfect' cluster strategy or institutional structures, government should accept a gradual strategy and try to identify problems and areas for improvement along the path of cluster development. By paying attention to the changing environment, governments can modify their strategies to meet changes when necessary. The feedback from actors at each stage provides plenty of evidence for the cluster builder to spot the mis-aligned aspects and seek re-alignment efforts to solve these problems.

## 7.2 General conclusion to the research problem

This thesis has sought to conceptualise the cluster building process and identify practical policy recommendations through theoretical exploration and empirical case research. The general conclusion showed the complexity of the cluster building process. Despite the governments of Scotland and Hong Kong investing a great deal to develop good technical constituents (technology, process and system), they were unable to compensate for their weak social constituents (people, institution, goals and perceptions) of the two regions. There was only a limited commercial linkage and knowledge flow among ICT companies and other supporting organisations. Besides, there was little incentive for the organisations to cooperate and the major actors of the two clusters had little perception of their place in the cluster. Neither cluster could be described as highly successful. This confirmed the argument in the literature that favourable institutional (Porter, 1990; Lundvall, 1992) and relationship characteristics (Cooke et al., 1997) are essential conditions for stimulating the cluster building process in a region. The processes of cluster formation in the two regions were still difficult despite the two governments' attempts to create 'institutional thickness' (Amin and Thrift, 1996).

The empirical data revealed that the decision to locate a company is dominated by commercial considerations such as the presence of a market or reduced costs. This highlighted the importance of cost and benefit conditions for companies to locate and begin agglomeration in a specific region, whilst local network opportunities were not usually regarded as an important concern. This point was vital, especially as cluster policies in Scotland and Hong Kong pointed towards MNCs as driving players. The governments must make their clusters very attractive by providing incentives and favourable conditions.

The results also demonstrated the 'problematic' nature of the cluster building processes. Both the clusters of Scotland and Hong Kong have been fraught with difficulties due to the misalignment between the perception and pursuits of policy makers and the interests of industry members. Cluster strategies in the two regions mainly concentrated on addressing market failures due to the inadequacy of private incentives in basic research. However, the two governments lacked an understanding of the changing economic cycle and the maturity of the technology so that their cluster policies failed to meet the needs of the industry. This highlighted the problem of implementing a universal, standard cluster policy programme in all regions. Cluster policy-makers should be aware of shifts in the technological trajectory, as well as the fluctuation of business cycles which may lead to instability in cluster development. To create the best results in cluster building, different technological and economic cycles should be differentiated with different strategies and policy instruments.

Cluster building is a purposive process. One important element is that the actors should know the new rules of the game and adapt their business practices accordingly. However, the findings challenged the assumption that cluster policies would readily transform the interests, pursuits and practices of actors. This study highlighted the importance of the 'governance' dimension in cluster creation, especially the processes of 'institutionalisation', 'familiarisation' and 'habitualisation', which were relevant to the emergence and development of a cluster. Amongst other things, the learning and knowledge exchange among the major actors and the government was essential to the cluster building process. In order to encourage actors to adopt a more participative style of collective learning, governments can create intermediary organisations to facilitate their collaboration. However, governments should be aware that different actors may have different objectives and respond differently to the incentive mechanism. Apart from the traditional technical and economic relations, cluster policies should also focus on the social and cultural dimensions of the relationship among the major actors and design activities to facilitate the development of informal networks.

Porter's (1990) work on clusters stressed the 'sectoral' dimension within regions. Therefore, his cluster policies always start with identifying the conditions of his 'diamond'. However, this research opened up ways of thinking about the possibility of stimulating the 'processes' of cluster-formation based on policy programmes leading to increasing returns. In the later stages of the cluster development, policies should diversify and gradually move from focussing on creating local synergies to a more open and flexible strategy for facilitating cluster evolution and expansion. Furthermore, the gradual extension of a cluster from a regional level to a national/international one also calls for new policy support for the enlargement of the spatial dimension of cooperation. To ensure the needs of the actors are being met along the path of cluster evolution, it is necessary to involve them in the communication process and collect feedback from them from time to time.

On the whole, this study enhanced our understanding of the practice of 'cluster-building' and revealed the importance of creating alignment conditions in the cluster building process. A cluster is conceptualised as a sociotechnical constituency and cluster building is a dynamic and evolutionary process of sociotechnical alignment. To build a cluster successfully government policies should focus on the re-alignment of various dimensions in the constituency and pursue a long-term incremental policy programme to deal effectively with the issues of major concern to the actors. Finally, the major contributions of this thesis are summarised in Table 7.1

Table 7.1 Summary of the major contributions of the thesis

- Pulled together relevant literature from various disciplines to clarify the nature and concepts of clusters
- Compared the similarities and differences of various frameworks for studying clusters, identifying their complementary insights
- Defined a qualitative methodology to study the cluster building process, in particular to look into the perception and networking activities of major actors

- Mapped the evolution of ICT clusters in Scotland and Hong Kong over the past ten years, and policy recommendations were made to improve the two regions' cluster building processes
- Proposed a number of tools for assessing the cluster building process, such as taxonomy of successful factors, diamond of socio-technical alignment, spider web tools for assessing the alignment condition, etc.
- Contributed to fill the 'processual' gap in the understanding of the cluster building process and identified general steps and good practices for policy makers in the build up clusters.

## 7.3 Implications for theory

This thesis has contributed to the understanding of the cluster building process. Despite the existence of extensive literature on clusters for many years, there is no systemic analysis of the nature of a cluster. Cluster was a rather 'fuzzy' concept that tended to confuse many researchers and policy analysts. This thesis pulled together insights from different academic disciplines to help clarify the concept. A cluster was systemically defined in terms of three dimensions, namely the geography, knowledge and institution, and network dimensions. The attributes of a cluster in these three dimensions were explained and elaborated. The extensive literature review of this thesis laid the ground work for future researchers and policy analysts who seek to define clusters. Also, by having a better understanding of the nature of a cluster, governments can design more appropriate policies to build a cluster.

This thesis compared six major approaches for studying clusters and identified their similarities and differences. The result showed that these six approaches were similar in recognising the importance of the geographical dimension of a cluster, pointing to similar institutional elements and addressing the importance of networks. However, these six approaches were different in their level of analysis and have emphasised different factors and functions of a cluster. By integrating the complementary insights of these six approaches a framework for studying the context, content and process of a cluster, namely the integrated NSI/IC/STC framework, has been proposed and implemented. This framework can be used by researchers and policy analysts to study clusters, and the cluster building process in particular, for the following reasons:

- It enables a multi-level analysis of clusters, ranging from project, cluster and regional/national industrial levels. It gives flexibility to researchers to study a cluster without the need to pre-define its boundary.
- It allows researchers to study the real-time development of clusters, even those still at embryonic stage. The importance of actors' perceptions and pursuits is emphasised which becomes a useful tool to study 'aspired' clusters.
- It provides a set of conceptual tools for cluster builders to map their contextual environment by making use of the combined IC and NSI framework, whilst the STC diamond alignment enables the policy maker to understand the key dimensions in the processes for building a cluster.
- It can be used as an essential tool to assess and evaluate the process or evolution of a cluster over time. The application of the STC diamond of alignment as a conceptual lens at each critical stage/phase enables cluster builders to identify the target problems and seek solutions to re-establish alignment.
- It is useful in making comparisons among different clusters in terms of their structures and processes, thus helping to identify and use the good practices for building clusters.

The findings of this thesis also shed light on the cluster building process. It revealed that the nature of cluster building is far more complicated than most policy-makers expect. It requires transformation at multi-levels, across multi domains, involves multi-actors and necessitates a holistic/systemic transformation. The taxonomy of factors for successful cluster building highlights the significant factors influencing the cluster building. It serves as a useful checklist for a government to plan and evaluate their clusters.

Many scholars question whether the regional/national level is an appropriate level of analysis for clusters, as the regional/national perspective tends to disappear and turn into a sector analysis when we focus on a specific industry. The evolutionary nature of the cluster building process revealed in this thesis helps resolve this paradox. The evolutionary process of a cluster cuts across the sector and regional/national divide and links the two together. It is suggested that the regional/national and sector perspectives can co-exist (i.e. SIS within a NSI or SIS enlarges to become a NSI) and they should not be regarded as mutually exclusive. In fact, their complementary insights enrich our understanding of the complications in the cluster evolution process.

The path dependent nature of technology development is showed by tracing the origin of the sector and the key historical incidents that took place along the longitudinal study which helped shape the industrial sector of today. This path dependent nature has profound lessons for governments to create paths for new emerging technologies (such as nano technology). The co-evolution of structure and actors within a cluster also deserve more theoretical exploration. It is useful to examine the changes of systems at different levels, as well as the behaviour of cluster's actors, in creating the dynamics to transform the system. If a government can pay attention to influence the path creation of a new technology today, such as supporting it with cluster policies, they are more likely to predict its future path and capitalise on its future opportunities.

## 7.4 Implications for policy and practice

### 7.4.1 For policy makers and analysts

#### a. Prior to the birth of clusters

In early 1990s there was a worldwide 'hype' of building high-tech clusters as a tool for economic growth and to develop national competitiveness. However, though cluster building was once regarded as fashionable, many countries have abandoned it in recent years, despite the huge resources they have invested on it. There is a lot of evidence that the number of highly successful clusters is in fact very few and the contribution of clusters to national economies is marginal. In the wake of weak factor conditions, or incompatible technological capability, many governments realised that building a globally competitive high-tech cluster was just a dream to them. The lesson for policy makers is that they should not be over-optimistic about cluster building in the first place. When a government decides to build a cluster it is important to seek the advice of experts and conduct a thorough mapping exercise to understand the strengths and weaknesses of their regions before they decide to commit huge resources. Sometimes, the opponents of cluster policy may have valid arguments that deserve careful consideration.

#### b. Designing cluster strategies

Once the idea of cluster building has passed various challenges, the government can proceed to draw a plan for cluster building. An important consideration in designing a cluster strategy is to identify the needs of the actors. In many cases governments just copy cluster strategies from other countries without thinking about the specific needs of their own country and this is often the major cause of downfall of many cluster policies. A government has to see the cluster from the viewpoint of the actors, and, more specifically, from the users' point of view. Policy makers should consult their opinion about what they need from the cluster, what benefit they want to get, what support they expect to obtain from the government and what are the most suitable ways to help them collaborate with other actors. By involving them in the cluster policy design process the government can design cluster strategies to meet their concerns. Besides, government can communicate more effectively with them about their needs through the mediation of industrial associations.

After the cluster strategy has been formulated, the government has to promote it along with the cluster vision to actors. It is a crucial step in giving meaning to a cluster because it shows why actors have to support the strategy and participate in the cluster activities. Such a vision should be meaningful in terms of the overall economic development and the cluster strategy should be regarded as an essential part of the nation's economic strategy. A promotion campaign can assist actors in the cluster to develop a clear understanding of the rationales behind the building of a cluster. For example, what a cluster is and why the government is creating it, why they chose a specific industry and why they provide funding for certain cluster initiatives. It is also the role of a government to define the cluster in layman terms, so that the actors will not be baffled by 'academic theories' (the two case studies showed the term 'cluster' was part of the problem) and misunderstand cluster building as a threat.

**c. Implementation of cluster policies**

Given the uncertainty of cluster development, a rigid policy will not be enough to meet the changing needs of a cluster. Hence policy makers are advised to mix and match a variety of policy instruments and differentiate them with the different technological trajectories and the business cycle at different stages of the cluster development. The forms of policy include:

- direct measures (technology targeting) and indirect measures (create an environment to facilitate technology development)
- different policies for supporting matured and emerging technologies
- initiate clusters at different levels, e.g. focus on specific sector, region or the whole country

- different means for supporting network building, such as creating intermediaries or giving incentives

Although there is no single ideal policy for building a cluster, a flexible policy framework is advisable since it is better at meeting the demands of a range of actors as well as the changing needs at different stages of cluster development.

The importance of intermediaries in enhancing innovation has been emphasised by a number of scholars. Intermediaries, like university technology transfer offices, public laboratories and technology centres, independent networking organisations and consultancies, can play a crucial role in bridging the gap between different actors. An effective intermediary should have a good understanding of the needs of both the user and the supply sides and be capable of coordinating them. Since the further growth of a cluster depends on the quality (depth) of networks, policy makers should design policies to support intermediaries and create favourable conditions for these intermediaries to perform their bridging function, such as providing financial assistance or helping actors to identify common ground with each other. In short, quality networks need time to develop, so support policy for intermediaries should also adopt a long term perspective.

**d. Managing cluster development**

A government manages the cluster development process in the following areas: 1). initiates the vision and actively promotes the vision to other actors; 2). injects resources into the cluster policy programme and persuade key actors to take part; 3). helps actors to integrate their technologies and human resources to the programme; 4). controls the direction of the programme and maintains alignment in different aspects of it; 5). balances the interests between different actors when conflicts arise. In short, the role of government is to manage people, networks and expectations within a cluster. The role of the government is not to tell the actors what to do, rather its job is to stimulate the awareness and interests of different parties and find common ground to make collaboration feasible.

One of the biggest obstacles in cluster building is that it takes a very long time to reach a critical mass and generate synergy effects. Many regions, due to political change, abandon the cluster building programme initiated by their political opponents in spite of the presence of the right conditions for a cluster. This highlights the importance of having a determined long term commitment to pursuing the cluster strategy. Cluster champions are influential in the cluster building process because they uphold the idea of cluster building despite facing opposition and challenges.

**e. Evaluating clusters**

Cluster policies involve the consideration of a wide range of social, economic and political factors. Hence a continuous assessment of the internal and external environment in which the cluster locates is of high importance to ensure its continuous and long term development. Governments should also maintain regular communication with the cluster actors. By collecting feedback from them, the government can help improve the governance of the cluster. The government can also initiate foresight exercises to be carried out jointly by public and private members. This can help identify emerging technologies, enabling government to create a path for them and also to exploit opportunities. Policy makers can also look at successful clusters in other regions as role models or bench marks. By analysing the cluster policies of other regions, governments can identify factors that affect their level of success and try to learn from 'best practices'. Sometimes governments may transfer some of the suitable practices to improve their own clusters.

In short, cluster strategy is a means, a tool to reach the final vision about the region. It gives a region a 'potential' for realising their specific target. However, building a cluster does not mean that it will necessarily succeed. Many regions mistake cluster strategy as an end rather than a means and this leads to failure. A cluster strategy can give a region the general direction and principles for developing technology. When a government announces the application of a cluster strategy it is only representing a starting point. It cannot automatically change the mindset and behaviours of actors. Thus, it requires incentives from the government to motivate the actors. A government cannot force a cluster to develop. The depth of networks and the strength of a cluster need time to build up and it requires a lot of compromising, reconciliation and complementarities to generate synergy and develop the competitive advantage of a region.

Table 7.2 Checklist of good practices for policy makers

**a. Initiating clusters**

- Avoid over-optimistic forecasts and ensure impartial appraisal

**b. Designing cluster policies**

- Design cluster policies from the user's perspective
- Define cluster meanings and clarify the direction

**c. Implementing cluster policies**

- Differentiate cluster policies according to technology nature and business cycle
- Give support to intermediary organisations

**d. Managing clusters**

- Give direction and principle, let companies find their own ways
- Have a long term commitment to cluster development

**e. Evaluating clusters**

- Maintain communication and collect feedback from cluster actors
- Examine 'best practices' from overseas clusters and learn from them

### 7.4.2 For company managers

Many scholars emphasise that companies are the most important actors in a cluster and their technological capabilities determine the success or failure of a cluster. Therefore, unless firms are willing to take part in the cluster, and make efforts to improve their technological competence, no cluster can be built. After all, it is the profit and growth of the private sector that determines the competitiveness of a nation.

#### a. Prior to the initiation of clusters

Prior to participation in a cluster it is important for company managers to have prepared their mindsets. Company managers should pay attention to the government's cluster promotion campaign (if any) so as to enhance their awareness and understanding of the new cluster policies. Firms have to try to understand the vision of the cluster and make connections between the vision and their situation. Private sector managers can conduct a self probing test to consider if they would like to take part in the cluster. The questions of the self-probing test may include:

1. Do we believe and support the vision? If not, why not? Is it too difficult to achieve?
2. Are we willing to participate in the cluster and change our routines if required? If not, what are the obstacles?
3. Do we have sufficient technological capabilities to achieve the cluster's target? If not, how do we acquire them?
4. Do we understand the rules for participating in a cluster? (e.g., our roles, contribution, what we want to achieve?)
5. Do we have the commitment to support the cluster? (it may take long time and may require companies to make unprofitable investments in the short term)

Companies that undertake this self-probing test will have a better understanding about their own situation. This test can help adjust the company's thinking before it participates in the cluster activities. It also enables them to recognise the potential steps they have to take or sacrifices they have to make in order to support the cluster programme.

**b. Participating in clusters**

Once a company has decided to participate in a cluster the very first thing they have to do is to stop thinking negatively (i.e., think that the vision is impossible) and use their will power and strength to support the cluster. At this stage companies should be receptive to incentives given by the government and use them to motivate themselves. A company can start making an initial step to engage in the cluster and try to make the most of it.

Companies participating in a cluster have to understand their own roles and contribute to enhancing the technological capabilities of a cluster. To achieve this, companies should focus on building their own technological capability. When talking about technological capability there is a common mistake that company managers think merely in technical terms. Yet research shows it is the problems with the management of technologies which lead to the failure of a technology. In the light of this, similar companies in a cluster should pay attention to building up their innovation management skills, including understanding user demand, developing proper financial and project management, and using appropriate marketing strategies.

It is stressed that every company is a small sociotechnical constituency and it is the building up of these small constituencies that makes up a mega one. Therefore companies can use the insights from the STC diamond to develop their small constituencies. For instance, the dimensions highlighted by the STC diamond—the technical and human resource base of the company, the nature and maturity of its technology, the problems that may obstruct its further growth, the potential resources and opportunities for its future development and the competition from other companies—must be kept in alignment in order to secure a healthy and continuous development of a small constituency. The ability of the company to align all these elements enables them to develop competitiveness and enables them to stay in the forefront of technology development.

Companies as participants of the cluster also need to internalise the rules of the cluster as part of their routines. For instance, companies purposively seek to develop external linkages with PSR as a mean to help them scan and select appropriate technology. By developing close relationships with suppliers and users, and communicating with them frequently, companies can acquire valuable information, including science and technology inputs. They can also learn the best practices for R&D and the technological process involved. Besides, companies are encouraged to develop 'reflexive learning', which means to learn consciously from their mistakes and explore ways to try to improve their performance. This higher level of learning helps the cluster to improve continuously and to maintain sustainability.

**c. Maintaining long term development of clusters**

Having an associative culture among actors is crucial for maintaining the long term development of a cluster. In an associative culture actors show their willingness to understand the needs of each other and to work together to achieve a shared vision. When problems occur they will try to solve them instead of blaming and attacking each other. Besides, they are willing to develop their chain of suppliers by transferring technologies to them and including them in their small sociotechnical constituency. They achieve collective learning by extending the learning process from their own company to its networks and teach organisations in its network the best practices. They also use their problem solving capabilities to transform the structure rather than being defeated by the environment. When facing the setbacks they will remember their higher vision. When the difficulties have passed they learn from their mistakes and make sure they are always on the right track. This collective learning capability cannot be acquired overnight. It needs time to build up, usually through 'learning-by-doing'.

Companies also have a role to uphold the long term development of a cluster by maintaining constant communications with the government and other actors in the cluster. Communication serves two roles in a cluster; first, companies communicating with other actors will improve each other's understanding, paving the way for alignment and the building of networks; second, communication can help maintain and strengthen the networks within the cluster. Also, companies can give feedback to the government about the problems of the cluster. This helps the government to find ways to improve the operation of the cluster. Frequent communication between the government and the actors also enables the policy makers to understand the emerging technology trends so that government can re-adjust their approach accordingly.

In short, despite the government being the main instigator of cluster policies, companies play a crucial role in cooperating with the government in the constituency building process. It is normal for companies to have different perceptions and interests, but they must be united by a shared vision. Merely joining the cluster is not enough. Companies should engage in perception and behavioural change to prepare for innovation, networking, learning and the building up of technological capabilities. As the cluster grows and matures, companies will take over the leadership role from the government. A mindset and behavioural transformation helps lay a solid foundation for changing roles. Once companies have recognised that engaging in a cluster is not a zero-sum game, but a win-win situation for all the actors, and the region as a whole, they are happy to continue the cluster building activities with a minimum intervention from the government.

Table 7.3 Checklist of the good practices for company managers

**a. Prior to the initiation of clusters**

- Conduct self-probing test to develop the perception for cluster building

**b. Participating in clusters**

- Understand own roles and contribution to the cluster
- Seek to develop competitiveness by aligning the key elements in own small constituency
- Internalise cluster mindset and behaviour

**c. Maintaining long term development of clusters**

- Collective learning and developing an associative culture
- Maintain constant communication with government

## 7.5 Limitations

This thesis has focused on the contextual (regional industrial), cluster, and project (in the Scottish case) level of cluster building, whilst the firm-level analysis has not been included in this research. Yet, a micro-firm level study of individual firms and other organisations in the cluster may help understand the psychological aspects of the actors, how their organisational structures, mode of operation and cultures have affected the dynamics of different institutions, thus providing a basis for investigating more richly the contextual, cluster and project levels of clusters.

Also, despite the author of this thesis's attempt at a synthesis of different research approaches to clusters into an integrated framework, a number of factors have not been fully incorporated into the framework. These include the cultural aspects, some psychological factors (i.e., trust), the demand side of the technology development process and the role of users, etc. This highlights the importance to further advance in the 'sociotechnical constituencies' approach, seeking to incorporate some of the relevant insights encountered during this study. In addition, the choice of a framework, in particular the complications of the STC approach due to the wide range of concepts behind the model, has caused many understanding difficulties for laymen (and governments) and thus hampered the effectiveness of this thesis in communicating the research results to policy makers.

## 7.6 Further research

This thesis reveals the evolutionary nature of cluster development. The findings can inspire researchers to pursue more longitudinal studies/historical studies to investigate the evolution and dynamics of clusters. Whilst this thesis adopted the qualitative approach to study the cluster building process, further research may include the use of quantitative methods to test some of the ideas about the evolution or dynamics of clusters, and to develop indicators to measure different aspects of the cluster building process which may yield a clearer assessment and more accurate evaluation of the progress of a cluster.

The ability to generalise from this research has been limited due to the adoption of the qualitative approach and the small number of cases under investigation. In order to generalise the findings, comparative studies are needed (as opposed to individual cases). Further comparative research can be done on different mature and emerging technologies, or user-centred innovations and producer-centred innovation processes. Moreover, the geographical coverage of cluster study can be extended to other regions/countries.

This thesis attempts to analyse the development of clusters at contextual (regional industrial), cluster and project levels. Further studies can focus on the intra-organisation (firm) level of actors in the cluster. This may yield a fruitful picture for understanding the micro-dynamic at work in a cluster and help understand the co-evolution process between structure and actors.

This thesis also highlights some research issues for further investigation. Examples of these issues include:

- The psychological aspect of cluster actors, such as their perception, goals, motivations and how can a government use policy instruments to influence their psychology. This may need new analytical frameworks (e.g., analysis of advertising and use of discourse)
- Explore ways to prevent mis-alignment or non-alignment. How to prevent the dissolution of a cluster? (networks are easier to dissolve than hierarchy) How can a cluster builder re-align various dimensions of a cluster?
- The ways to maintain interaction among different types of organisations in a cluster and how to maintain dialogue among them. Issues related to the interface mechanism have been dealt extensively in the Triple Helix model (Etzkowitz and Leydesdorff, 2000) in recent years and deserve further elaboration.
- The creation of dynamic at each level and how to channel dynamics from one level to another puzzles many scholars and policy makers. A better understanding of the dynamics at work can help policy makers to create paths for emerging technologies.

In addition, the impact of globalisation challenges the appropriate boundary of a cluster and necessitates further research on the following issues:

- The relations between global value chains and innovation systems and clusters
- How knowledge is distributed across different firms, different organisations and countries along the global value chain?
- What are the roles of MNCs as a major international actor and their role in clusters?
- Deeper understanding of the boundaries of clusters and the interactions between clusters in different countries.

Also, it is worth paying attention to the new complex variables which have now entered the dynamics of technology development. These new variables include the rise of China and India as the biggest technology markets, as well as the emergence of major new technologies such as nanotechnology, biotechnology and information technologies and the convergent trend of different technology sectors. Finally, it is important to gain understanding of the origins, development, dynamic and impact of virtual clusters making extensive use of online technologies and environments.

## 7.7 Chapter summary

This chapter has summarised the contribution of this thesis in terms of advancing the knowledge of clusters and implications for policy practice. Sections 7.1 and 7.2 have presented the conclusions regarding the research questions set in Chapter 1. The research showed that the cluster building process is more complex than suggested in the literature. The cluster vision was driven by problems and cluster strategy was regarded as a tool to solve these problems. Cluster strategies were translated into public policies through the institutionalisation process. Problems were an integral part of the cluster building process. The STC diamond of alignment highlighted the six problematic areas to which policy makers should pay special attention. The evolutionary and uncertain process of cluster building called for an open and flexible approach and constant feedback was crucial for maintaining a cluster's continuous development.

Section 7.3 summarised the implications for theory. This thesis helped clarify the 'fuzzy' concept of cluster. It also proposed an integrated IC/NSI/STC model which was used in the study of cluster building process. The findings of the evolutionary nature of clusters helped bridge the sector and regional/national divide which were deemed as co-existing with each other. The insights about the path dependent nature of technology development also shed light for government in creating paths for emerging technologies to develop.

Section 7.4 summarised the crucial implications of this thesis for policy makers and company managers. It was advised that policy makers should not underestimate the difficulty of cluster building, but should have a thorough understanding of the needs of the cluster actors. Instead of focussing on creating ‘factor conditions’, governments should pay attention to the cluster building process to define the meaning of a cluster, to differentiate a variety of policy instrument according to different timing and to maintain commitment and pursue ‘best practices’ to build clusters. Company managers also have to align their perception and goals to the vision of the cluster. They should also contribute to the development of this vision. In supporting the cluster development companies should make efforts to develop their own small sociotechnical constituencies, to network and communicate with their supply chain companies, learn from each other and to innovate, so as to develop their technological capability. Companies should actively communicate with governments to express their opinions.

Section 7.5 highlighted the limitations of this thesis. A number of factors have not been covered adequately in this thesis, such as cultures, role of users and the generation of dynamics at the micro-level of the firm. In Section 7.6, a number of new research areas were proposed. For instance, to develop indicators for cluster building by quantitative methods, to extend the research to different technologies, regions, and virtual clusters, to investigate the development of networks among different institutions and the generation of dynamics among them, as well as exploring the impact of globalisation on the cluster building process.

Finally, the author would like to end this thesis with a quotation from an ancient Chinese philosopher. ‘*A journey of a thousand miles must begin with a single step—Lao Tze*’. If a government want to build up the competitive advantage of their nations, they have to gather their strength and determination in taking the initial step to begin building their clusters—it is the first step on an endless journey.

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