Resolving the paradox of location in a global economy: Cluster facilitation and network management in the biotechnology sector

by

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Abstract

Cluster policy is at the crossroads as governments widely support the local agglomeration of companies and research institutes, but success or failure seems arbitrary for those ‘Silicon Somewheres’. Faced with limited proof of ‘what works’ for clusters, frustration is spreading among policy makers and stakeholders. The study offers a comparative analysis of high-technology clusters around the globe with the objective of finding a generalizable mechanism for making cluster policy successful. Interviews conducted with officials, researchers and industry stakeholders in Chicago, Copenhagen, Singapore and Vancouver reveal that networks have found a novel way of cluster support by having a ‘facilitator’.

This network management institution or individual is able to connect and support cluster stakeholders while simultaneously linking them to government with the goal of better tailored policy and ultimately more successful innovative processes. The dissertation offers a new theoretical framework for investigating the facilitation mechanism based on intersecting science and technology policy, network management and innovation systems literature. The study highlights the fact that the key to success is the creation of capacity for networking (collaborative capacity) and identifying useful knowledge, knowledge gaps and future developments (absorptive capacity) rather than focusing solely on output. The central findings are threefold: Not only does facilitation exist in different parts of the world, it also enhances performance and varies depending on location. The variations include a government- and stakeholder-funded model in most European countries, an independent model in North America and finally, a government-financed model in Asia.

Keywords: Science and technology policy; innovation; cluster; cluster facilitator; network management; collaborative and absorptive capacity
Acknowledgements

So much about this journey was determined by pleasant surprises and coincidence. Do not get me wrong, the hard work definitely was not. But ending up in Vancouver at Simon Fraser University and having Mike as my supervisor were things that I only had limited control over. And they turned out to be some of the best things that ever happened to me. I was not sure what to expect when I arrived with two suitcases in this city. And thanks to the support and encouragement from a great number of individuals everything fell into place perfectly. I learned that it is about the journey, about the people – especially about welcoming, inviting and helpful Canadian people.

First, I would like to express my deep appreciation and gratitude to my advisor, Michael Howlett, for the patient guidance and mentorship. Mike not only supported me at an academic level, but also taught me so much about Vancouver, Canada and Singapore. I will never forget his first advice, which was: ‘if it is sunny, go outside’. This led me to enjoy the few sunny Vancouver days and probably inspired many new ideas that would have never found me at my desk. I learned a lot, although I am still trying to figure out how he makes hard academic work look so easy and fun. Mike’s practical approach to the PhD program and research in general got me where I wanted to be quickly and efficiently and his generosity in sharing ideas and connections jump-started my academic journey.

I would also like to thank Steven Weldon, who, besides giving me valuable insights on research methods, never failed to motivate me during my studies. I learned that a word of encouragement can go a long way and hopefully I will be able to pass it on to my own students at some point. He was also the first face I saw at SFU and his ability to relate to differences between Germany and Canada made the beginning so much easier. Danke. Gratitude also goes out to David Laycock, who offered me a helping hand during administrative and funding challenges and made every exam he chaired fun. Thank you also to Laurent, who served on my supervisory committee and kept me on my toes about why clusters are (still) important in a global economy.
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Thank you to all my Vancouver friends, you made this a unique, fun and memorable experience. To Vancouver, for the beautiful city you are with the calming ocean, breath-taking mountains and glorious summers. And those Vancouverites that introduced me to Ultimate Frisbee, which kept me away from my desk when I needed it most.

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<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*STAR</td>
<td>Agency for Science, Technology and Research</td>
</tr>
<tr>
<td>BC</td>
<td>British Columbia</td>
</tr>
<tr>
<td>BCKDF</td>
<td>British Columbia Knowledge Development Fund</td>
</tr>
<tr>
<td>BIO</td>
<td>Biotechnology Industry Organization</td>
</tr>
<tr>
<td>CBN</td>
<td>Chicago Biotech Network</td>
</tr>
<tr>
<td>CDRD</td>
<td>Centre for Drug Research and Development</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>CIEL</td>
<td>Copenhagen Innovation and Entrepreneurship Lab</td>
</tr>
<tr>
<td>CIM</td>
<td>Chicago Innovation Mentors</td>
</tr>
<tr>
<td>CIMIT</td>
<td>Centre for Integration of Medicine and Innovation Technologies</td>
</tr>
<tr>
<td>COBIS</td>
<td>Copenhagen Bio Science Park</td>
</tr>
<tr>
<td>DBF</td>
<td>Dedicated Biotechnology Firms</td>
</tr>
<tr>
<td>DCEO</td>
<td>Department of Commerce and Economic Opportunity</td>
</tr>
<tr>
<td>DTU</td>
<td>Danmarks Tekniske Universitet [Technical University of Denmark]</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EDB</td>
<td>Economic Development Board</td>
</tr>
<tr>
<td>ERDF</td>
<td>European Regional Development Fund</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FDA</td>
<td>Food and Drug Administration</td>
</tr>
<tr>
<td>FDI</td>
<td>Foreign Direct Investment</td>
</tr>
<tr>
<td>GII</td>
<td>Global Innovation Index</td>
</tr>
<tr>
<td>iBIO</td>
<td>Illinois Biotechnology Industry Organization</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technologies</td>
</tr>
<tr>
<td>IIVF</td>
<td>Invest Illinois Venture Fund</td>
</tr>
<tr>
<td>IMCB</td>
<td>Institute of Molecular and Cellular Biology</td>
</tr>
<tr>
<td>IMO</td>
<td>Illinois Medical District</td>
</tr>
<tr>
<td>CEC</td>
<td>Chicagoland Entrepreneurial Center</td>
</tr>
<tr>
<td>IP</td>
<td>Intellectual Property</td>
</tr>
<tr>
<td>IPO</td>
<td>Industry Partnership Office</td>
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<tr>
<td>IPR</td>
<td>Intellectual Property Rights</td>
</tr>
<tr>
<td>IRAP</td>
<td>Industrial Research Assistance Program</td>
</tr>
<tr>
<td>ISTC</td>
<td>Illinois Science and Technology Coalition</td>
</tr>
<tr>
<td>ISTP</td>
<td>Illinois Science and Technology Park</td>
</tr>
<tr>
<td>ITAS</td>
<td>Industry Technology Advisors</td>
</tr>
<tr>
<td>ITC</td>
<td>International Trade Centers</td>
</tr>
<tr>
<td>MassBio</td>
<td>Massachusetts Biotechnology</td>
</tr>
<tr>
<td>MEC</td>
<td>Manufacturing Extension Centers</td>
</tr>
</tbody>
</table>
MoH Ministry of Health (Singapore)
MoE Ministry of Education (Singapore)
MVA Medicon Valley Alliance
NAO Network Administration Organization
NGOs Non-governmental Organizations
NIH National Institute of Health
NPM New Public Management
NRC National Research Council
NRF National Research Foundation
NSERC National Sciences and Engineering Research Council
NUH National University Hospital Singapore
NUS National University of Singapore
OECD Organization for Economic Cooperation and Development
ØSR Øresund Science Region
PAC Political Action Committee
PBA Place-Based Approach
PCT Patent Co-operation Treaty
PMET Professional, Managerial, Engineering and Technical (jobs)
PTAC Procurement Technical Assistance Center
R&D Research and Development
RIE(C) Research, Innovation and Enterprise (Council)
RPMs Research Project Managers
SBDC Small Business Development Centers
SBEAP Small Business Environmental Assistance Program
SI Systems of Innovation
SIgN Singapore Immunology Network
SMEs Small and Medium Enterprises
SSBCI State Small Business Credit Initiative
STEM Science, Technology, Engineering and Mathematics
TIP Technology Innovation Program
TTO Technology Transfer Office
UIC University of Illinois at Chicago
UK United Kingdom
US United States of America
VMS Venture Mentoring Service
WBC World Business Chicago
WD Western Diversification
WEF World Economic Forum
WEPA Western Economic Partnership Agreement
Glossary

Absorptive Capacity
Absorptive capacity focuses on the ability of a firm, cluster or country ‘to integrate the existing and exploitable resources – technological opportunities – into the production chain, and the foresight to anticipate potential and relevant technological trajectories’ (Narula 2004, 6).

Biotechnology
‘Application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services’ (OECD 2005, 9).

Cluster
Clusters are geographic concentrations of interconnected companies and institutions in a particular field (Porter 1998, 78).

Collaborative Capacity
Collaborative capacity encompasses the elements of purpose, structure, resources and communication in network relationships.

Competitive Advantage
Degree to which a country, company or institution can under fair and free conditions meet the test of international markets, while simultaneously maintaining and expanding the real income of its people or employees over the longer term (OECD 1992).

Global value chain
The range of activities involved in creating, producing and delivering a product in a global market and with international connections.

Innovation
Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD 2005, 46).

Innovation-driven economy
Innovation-driven countries focus predominantly on knowledge-intensive activities and portray characteristics such as spending more resources on the production of knowledge and over 60% of the population ages 25-64 has completed upper secondary schooling. Further, having high ICT investment (about 7% of GDP), and the business sector being the main funder and performer of R&D (Godin 2006; OECD 2001).

Knowledge-based economy
Economies ‘which are directly based on the production, distribution and use of knowledge and information (OECD 1996, 7).

Multi-level governance
The multi-level perspective is mostly applied in a European
context in which the system is characterized as having (1) shared decision-making competences; (2) being non-hierarchical and (3) non-majoritarian. These components together form a governance pattern that is highly dynamic (Kaiser & Prange 2002) and varies over time and across policy areas (Kohler-Koch 1999).

Place-based approach
The place-based approach has two fundamental aspects to it: First, it emphasizes the importance of a place or geographic context, which refers to social, cultural and institutional characteristics (Barca, McCann and Rodriguez-Pose 2012). And second, place-based policy acknowledges the various levels of government and the different policy layers involved.

Science Park
An area with an agglomeration of institutions dedicated to scientific research.

Technology Park
An area with an agglomeration of institutions dedicated to the commercialization of scientific research (Mroczowski 2012).
1. Introduction

Cluster policy has gained momentum among governments around the world in support for economic and innovative capacities alike. Clusters have proven to be a source of success for both, as they are seen as local concentrations of knowledge providers from which various kinds of knowledge spillovers and knowledge links emanate for the region (Cooke et al. 2007). This originates from the observation that densely linked companies and research institutions in a common industry locate in the same geographic area (Porter 1998). And while some argue that the success of each cluster is dependent upon a unique set of factors (Feldman & Francis 2004), others support the emulation of the well-known computer software cluster Silicon Valley. Both approaches are being criticized, as the latter one can lead to ‘wishful thinking’ clusters, which require large amounts of funding without the proper networking infrastructure or players (OECD 2011). Figuring out unique support mechanisms is also costly due to limited learning from other clusters and lengthy periods of ‘learning by doing’. As the OECD (2011) highlights, ‘it is not uncommon for policy makers to be vague and unrealistic about a cluster policy with expectations far exceeding resources and potential’ (Ibid, 4).

A closer look at governments’ efforts shows that in many cases the attempt to create such networks results in failure. An example for this is New Jersey’s attempt to create a Silicon-Valley-like high-tech sector, which eventually led to a limited research consortium (Leslie & Kargon 1997; Feldman & Francis 2004). This highlights the need for a study that systematically analyzes an underlying mechanism that can be adjusted to country- or region-specific characteristics while incorporating lessons about innovative processes and networking. The dissertation fills this gap by focusing on the role of a cluster facilitator posing as a link between government and stakeholders and supporting policy decisions as well as networking.

The strengths of the cluster framework stem from the assumption that spatial concentration of enterprises, research institutes in cooperation with government,
increase regional competitiveness through proximity (Porter 1990). The rational for the relationship between clusters and regional performance levels is that 1) productivity is enhanced by lowering transaction costs, which are fuelled by local industry agglomeration; 2) innovation is dependent on interactive knowledge exchange, enhanced by networking and 3) employment results from new business formation is aided by learning, communication and commercialization – attributes that have been ascribed to clusters (Karaev et al. 2007; Porter 1998). Studies in support of this have largely been case-specific, however they do point towards the role of agglomerations in explaining economic performance of regions. A study by the European Commission for example reveals that when comparing clustered and non-clustered companies, those in a cluster are more innovative (EC 2008). Porter’s (2003) research of US clusters further shows that ‘US regions that have a high proportion of their total workforce located in ‘strong’ clusters enjoy a higher level of economic development in the form of average wages and employment growth in addition to […] higher patenting’ (EC 2008, 23). These results suggest that innovation is indeed spurred by clusters. They further provide a framework to rethink and refocus economic policy, align federal, state and local policy and reflect the nature of the economy by highlighting real-world interactions, connections, transactions and dealings of firms. Thereby, the cluster as an economic tool prevents oversimplification and emphasizes vertical (global to local) and horizontal (cooperation) connections (Porter 1998; Muro & Katz 2010). Thus, during the time of financial constraints, ‘cluster policy is regarded as a promising approach to strengthen the innovative capacities of regional systems, leading to greater competitiveness of a region and its actors’ (Schmiedeberg 2010, 390).

In other words, focusing on spatial agglomeration in an increasingly globalized world is deemed a successful strategy for policy makers to support growth. This ‘paradox of location in a global economy’ (Porter 1998, 78) however highlights the complex demands of today’s economy towards policy. While enduring competitive advantage in a global economy is determined by local factors – knowledge, relationships, motivation – the challenge is that policy cannot be static or confined to one space. The local factors evolve around the role of knowledge transfer, which is central to the innovation process. Researchers make a distinction between tacit knowledge and information. While information or explicit knowledge is highly codified, tacit knowledge
lacks codification and often needs face-to-face efforts to be acquired (Nonaka & Takeuchi 1995; Powell & Grodal 2005). Thereby, ‘complex tacit knowledge can become more explicit as partners develop a wider bandwidth of communication’ (Powell & Grodal 2005). This implies that communication and collaboration are central to the exchange of such knowledge between stakeholders in a certain location. However, for actors to be interested in knowledge transfer and recombination, the value of the innovative output has to exceed the costs of such a transfer and use of knowledge. This is only the case when there is a medium range of knowledge codification, which includes information that has important elements of novelty, while having no significant barriers to transfer. In this, government can lower the costs of transfer through enabling collaboration mechanisms and connecting stakeholders to outside knowledge sources across industries and countries. (Powell and Grodal 2005; Moodysson, Coenen & Asheim 2010). The same is true for investors and human capital. This points towards the vital connection between spatial levels and the construction of general and place-based elements in policy. Policy-makers need to have the ability to access and match relevant programmes to particular gaps in the cluster while being plugged into global developments (Bradford & Wolfe 2013). So far, governments and researchers have been struggling to find evidence for ‘what works’ to establish and sustain successful clusters. As shown in Figure 1, policy tools range from targeting specific companies (‘picking winners’) to adjusting wider framework conditions for agglomeration, such as tax breaks. This often arbitrary mix of ‘new’ and ‘old’ approaches to local innovation processes shows that policy-makers are in the dark about which instruments work. They are further constrained by existing regulations and the lack of evidence for the effectiveness of those tools.
In response to these challenges in cluster policy, the study focuses on the implementation of a core node in networks, the facilitator, which can inform policy and enhance the levels of absorptive and collaborative capacities of stakeholders. The collaborative capacity framework entails the networking elements of purpose, structure, resources and communication, while absorptive capacity describes the ability to integrate and exploit knowledge inside and outside of the cluster. These elements have been connected to more successful innovative processes as cooperation leads to the exchange of knowledge as well as mutual support and the ability to identify knowledge gaps and address those through inside and outside linkages helps companies and research institutes to be competitive. Both, the absorptive and collaborative capacity frameworks are connected to performance levels by developing the heightened communication and knowledge exchange among stakeholders and the ability to identify relevant information from internal and external network sources. Hence, the study makes the connection between the existence of a cluster facilitator, the heightened capacity levels and ultimately performance.

The manager facilitating these capacities can be an individual, a local association or knowledge institute (Mesquita 2007; Gagne et al. 2010). This role differs from the one

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**Support activities of public authorities: assessment of current levels and desire for improvement**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Currently provided</th>
<th>Should improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation of public events</td>
<td>45</td>
<td>57</td>
</tr>
<tr>
<td>Support the improvement of the region-cluster reputation</td>
<td>57</td>
<td>44</td>
</tr>
<tr>
<td>Facilitate transmission of information</td>
<td>69</td>
<td>43</td>
</tr>
<tr>
<td>Direct financial support to finance specific projects</td>
<td>69</td>
<td>41</td>
</tr>
<tr>
<td>Facilitate networking with universities, administration</td>
<td>69</td>
<td>40</td>
</tr>
<tr>
<td>Facilitate networking with firms</td>
<td>61</td>
<td>39</td>
</tr>
<tr>
<td>Facilitate admin. procedures</td>
<td>61</td>
<td>34</td>
</tr>
<tr>
<td>Facilitate trans-national relation with other clusters or geographic areas</td>
<td>74</td>
<td>33</td>
</tr>
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<td>Provide buildings or other infratr.</td>
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<td>Support incubator development</td>
<td>51</td>
<td>27</td>
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<td>Tax reduction schemes on R&amp;D and innovation expenditures</td>
<td>57</td>
<td>26</td>
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<td>Tax reduction schemes on non-R&amp;D and non-innovation expenditures</td>
<td>68</td>
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*Figure 1 Support activities of public authorities in the EU (EC 2006, 7).*
of an anchor firm or ‘champion’ in a cluster. Instead of having firm-related or personal gains through cooperation, the facilitator takes a neutral role or rather creates a ‘neutral corner’ for all participants. Activities by stakeholders such as collaborative action, forming strategic alliances and sharing value or supply chains benefit from this neutral corner (Cooke et al. 2007). The facilitator uses knowledge gained of the individual stakeholders within the cluster to support them in exploring development options. Throughout the development of a more mature cluster, the facilitator further motivates and empowers senior cluster stakeholders. This is followed by the development of a broader, long-term agenda and definition of short-term actions that will start moving the cluster in the direction of a ‘vision’ and defined goals. Once these elements are established, the facilitator can shift towards seeking opportunities to connect to other clusters and be more competitive beyond the regional or even national level (Ffowcs-Williams 2004). Research shows that ‘clusters usually have a critical need of some kind of leadership, but neither individual nor organizational actors wish to be led’ (Sydow et al. 2011). This dilemma can only be ‘managed’ or solved in a way a facilitator works – by addressing these issues non-hierarchical while enabling the cluster in terms of cooperation and moving forward. In the role of a cluster manager, the facilitator is able to guide co-operations in the network and define goals as well as make linkages within and outside of the cluster for enhancing resource flow. These activities together sum up to the absorptive and collaborative capacity a cluster can have – its ability to use its knowledge resources (inside and outside of the cluster) and to create linkages that lead to purpose, structure, resources and communication channels (Giuliani 2005; Lai 2011). These capacities, created through the work of the facilitator, are then linked to the performance of the cluster. The hypothesis is that cluster performance rises with the levels of absorptive and collaborative capacity, because these activities enable the cluster to make use of the geographic proximity and gain access to extra-cluster sources – financially and knowledge-wise.

Overall, the facilitator establishes a support structure that serves both, policy-makers and cluster stakeholders. For the network, the manager connects players by offering various services that enhance collaboration. Those include for example
meetings introducing researchers to companies and entrepreneurs to angel investors\(^1\) or advertising the cluster globally in order to attract venture capital. Further, the facilitator links cluster players to government by posing as a communication channel between both groups. This helps to articulate the needs of stakeholders to policy makers and also inform the cluster about public funding opportunities.

An example of cluster success after facilitator implementation is the Melbourne Biotechnology Network. The Australian government has particularly invested into Victoria’s growing biotechnology field with about A$3 billion (nearly US$2.4 billion) (McCurry 2009). The main research institutions and the basic elements for biotechnology clustering were already available in the Melbourne region, but it was not until 2001, when the ‘Committee of Melbourne’ created the cluster facilitator ‘BioMelbourne Network’, that connections were established to the national and local research community and organizations got the necessary governmental back-up (Trudinger 2002). Today, the network has a membership base of 171 organizations and a close relationship with various government departments. Melbourne, as the ‘biotechnology capital’, now hosts almost half of Australia’s biotech companies and is able to connect different bio hubs in biomedicine and agriculture with nine universities (Enright & Roberts 2001; Kelly & Chiang 2008). Another example is the Cambridge high-tech cluster in England. Since the 1990s, the St John’s Innovation Centre played a key role in managing the network. By providing business support services and collaborating with the European Business and Innovation Centres, it was able to secure funding from the Regional Cohesion Policy Fund and spur collaboration among stakeholders. Today, the Centre is independent of public subsidies and pushed the cluster towards being one of the world’s leading high-tech clusters with around 1500 ventures and 40,000 jobs (EC 2008).

To prove that this relationship between the implementation of a cluster facilitator, rising levels of absorptive and collaborative capacities followed by higher cluster performance exists, the study uses case analysis and survey research. The survey gives insight into the activities and characteristics of facilitators by focusing on the

\(^1\) An angel or private equity investor is an individual, who provides private capital for small start-up companies.
management and networking aspects, while the in-depth semi-structured interviews in selected cases reveal details about the mechanism of how facilitator work impacts cluster competitiveness. Together these methods produce a more complete and accurate picture of the ‘if’, ‘how’ and ‘why’ facilitators change the performance of clusters. The goal is to move beyond the (implicit) assumption that cluster policy is successful and money well spent. By complementing case study research with survey data, the study is able to deepen the understanding of the mechanism of facilitator work (Schmiedeberg 2010; Guy 2003). This is done by causally linking the investment into the work of a facilitator to the success of the cluster, something that has not been systematically done before.

1.1. Hypotheses

The observed link between facilitation and cluster performance, the need for trust in the facilitation process and the importance of collaborative and absorptive capacity, motivates the following hypotheses:

*H1*: Trust, legitimacy and the closeness to government are positively associated with the ability of the cluster facilitator to guide the network.

The fact that anyone in the network could connect stakeholders or hold networking event, does not make them a cluster facilitator. Instead it is more likely for an institution or person that stakeholders trust in as being neutral and doing things in the cluster’s best interest that earns the legitimacy to do so. Also, closeness to government can lead to higher levels of trust and legitimacy as it can create communication channels between government departments and network stakeholders. An over-emphasis on government relation could, however, be damaging for the relationship between facilitator and stakeholders.

*H2*: The existence of a cluster facilitator is positively associated with the levels of collaborative and absorptive capacity.

It is hypothesized that the work that cluster facilitators carry out is positively associated with the capacity levels of the network.
**H3: High levels of collaborative and absorptive capacity are more likely to lead to higher cluster performance.**

Higher capacity levels are positively association with performance in the sense that they foster networking, knowledge-transfer and ultimately innovation. Possessing collaborative capacity makes it more likely for stakeholders to being able to communicate and transfer (tacit) knowledge in a way that is beneficial. On top of that, absorptive capacity levels describe the ability to gain relevant knowledge from outside the network, but also use it in a way that makes the stakeholders and ultimately the cluster more competitive.

**H4: There is a positive relationship between the presence of a cluster facilitator and the performance of the cluster.**

Based on the previous hypotheses, there is a logical chain with the capacity level as intermediate causal variables. The presence of a facilitator positively associated with capacity levels, which make higher performance more likely. This does not mean that the facilitator is the sole contributor to the competitiveness of a cluster, but does impact performance in a positive way.

Overall, the expectation is that cluster facilitators enhance the competitiveness of a cluster through certain characteristics and activities. Several studies identify characteristics and competencies cluster facilitators usually have or should have (Wardale 2008; Stoerring & Christensen 2008; Ingstrup 2010). Often only due to these personal traits and professional skills, the facilitator is able to carry out activities that possibly lead to higher performance. Wardale (2008) defines five facilitator characteristics:

- Humility: the facilitator is approachable and not forcing own beliefs in the process;
- Flexibility: being open to changes and other approaches;
- Sincerity: being empathic and acting in accordance with own values;
- Professionalism: having predetermined knowledge of cluster dynamics and confidence to deal with them;
- And awareness of the dynamics arising from power, control and prestige.
Together, these traits emphasize the importance of neutrality and impartiality and a general experience or training of the facilitator in cluster management. This is also true for the favoured competencies, which include being able to establish and maintain positive client relationships, developing a participatory environment, stimulate group creativity and the production of effective results by guiding the group (Wardale 2008, 51). Together the characteristics and competencies create trust in facilitator work and also make the facilitator’s leadership role legitimate. Ingstrup’s (2010) summary of this set of abilities and traits is that a facilitator is ‘one or more persons whose task is to guide and coordinate several actors and their resources and activities in order to reach common goals and objectives formed by the interests of internal and external stakeholders’ (Ibid, 28).

The problem many studies face when dealing with social relationships in networks and their connection to a certain outcome, are the intended and unintended consequences of such a leadership role. First, people with these characteristics are more likely to be in such a position and are also more likely to acquire the competencies listed above. Second, beside the actions carried out based on those competencies, there are unintended network dynamics. These can be performance enhancing, like social capital and trust building, or harming, such as limiting the cluster in development and cooperation. For the former, social capital is powerful, but hard to track as an economic good. ‘The components of social capital are many, varied and in many instances, intangible – as they consist of different types of relationships and engagement’ (Dasgupta 2000, 325). Still, the believed effect is that ‘those forces increase the potential for economic development in a society by creating and sustaining social relations and patterns of social relations’ (Turner 2000, 95).

Hence, to focus on the measurable effects of facilitator work, the absorptive and collaborative capacity frameworks give a list of activities that can be counted and connected to performance, keeping in mind the effects of social capital and group dynamics. The concepts are able to break down the facilitator work into observable units and define those activities. These are then linked to the growth trajectory of the whole network (Giuliani 2005; Lai 2011).
1.2. Context

Situating cluster policy in the larger context of industrial policy shows that current research struggles with the complexity of what such policy entails and how it differs from traditional approaches. Cluster policies take different forms and follow different objectives which makes it difficult to clearly categorize them (EC 2008). In addition, the definition of clusters varies in terms of the extent and depths, the degree of formalization and the permanence of those linkages. Further, the role played by endogenous and exogenous resources and most importantly for this study, the role of public intervention, is often unclear (Nauwelaers 2001). The evolution of industrial policy highlights some of the overlapping and distinct aspects of current cluster policy.

Post-World War II, industrial policy is best described as science policy, due to the belief that investments in science have a strong impact on the economy. This is connected to the government funding of military operations and the development of rather general technologies. Early studies, like the Vannevar Bush Report (1945) and the attempt to measure the impact of R&D efforts in England by Bernal (1939) portrayed science as the ‘endless frontier’ (Lundvall & Borras 2005). During the economic crisis of the 1970s, the innovation concept became more broadly used, due to the fact that one cause of the downturn was seen in the inability to exploit new technologies (Freeman et al. 1982; Rothwell 1982; Lundvall & Borras 2005; Perren & Sapsed 2013). However, some interpreted the crisis as a sign of fundamental incompatibility between market and politics. This was due to two related aspects of government intervention, first, political responses ignored the institutional foundations of stability in a mass-production economy and second, the dramatic spread of mass production and its resulting exhaustion of the possibilities for further growth within the regulatory system that was created after World War II (Piore & Sabel 1984).

Parallel to the development of industrial policy, economic studies contributed to the discussion based on research focusing on the relationship between technology and economic growth. As an alternative to neo-classical economics, Nelson and Winter (1982) laid the groundwork for the evolutionary theory of economic change. With the analogy to biological evolution in mind, they argue that firms, based on variation or new products, grow and compete. This not only creates routines within firms, but also a ‘self-
replication’ mechanism (Nelson & Winter 1982; Martin 2012). However, it is hard to predict the impact of policy measures based on this, due to complex effects. Researchers further lack the relevant counterfactual evidence, as to what may appear to be successful in one place might not be the best outcome for that region or country (Pack & Saggi 2006).

Clustering, in response to these processes, gained momentum in the policy realm in the 1990s, based on successful examples such as the Third Italy\(^2\) (Piore & Sabel 1984), Silicon Valley and Route 128 (Saxenian 1999) as well as the extensive work by Porter on industrial clusters (1998). This also marks the departure from the neoclassical view towards an endogenous one, where the investment in human capital, innovation and knowledge are significant contributions to economic growth (Kline & Rosenberg 1986). Cluster policies can be divided into three different categories, reflecting the different motivations and policy objectives behind them:

The first and most horizontal category concerns ‘facilitating policies’ directed towards creating a favourable microeconomic business environment for growth and innovation that indirectly also stimulate the emergence and dynamics of clusters. A second category comprises ‘traditional framework policies’, such as industry and SMEs policies, research and innovation policies, and regional policy that often use the cluster approach to increase the efficiency of a specific instrument. A third category consists of ‘development policies’ aiming at creating, mobilising or strengthening a particular cluster category resulting in specific sectoral cluster initiatives. (EC 2008, 32)

Thus, the ‘protectionist’ rationale of ‘old-style’ industrial policy has been replaced by a more market-oriented economic policy, where the framework conditions are shaped for more competitive industries. Governments, companies and research institutions alike

\(^2\) The concept of the so-called ‘third Italy’ describes ‘the thriving firm structures witnessed in the Northeast and centre of Italy, which contrasted with the stagnation in the poor South (‘second Italy’) and a recession in the traditionally rich Northwest (‘first Italy’). The performance of the Northeast and centre of Italy sparked interest in the economic and social fabric of the region, marked by the concentration of firms clustered in specific localities according to industrial sectors. These clusters were able to establish strong positions in world markets in a number of traditional product categories, including shoes, furniture, tiles, musical instruments, etc. Progress seemed promoted by the capacity of the clusters to innovate in terms of production processes as well as product qualities. In connection with the interest in the ‘third Italy’, the literature examined properties in industrial organisation that facilitate flexible structures and specialisation. The focus was on the role of small and medium-sized enterprises (SMEs) (Sengenberger et al., 1990; Loveman and Sengenberger 1991)’ (Andersson et al. 2004, 16).
are looking for the ‘cluster effect’. This can happen naturally, as examples in Italy and California suggest, however ‘the truth is that it takes a very focused and strategic approach to bring companies and organizations from the value chain together to form partnerships for funding, research and revenue opportunities’ (Bagley 2012). There is an ongoing discussion about the balance between ‘traditionally conceived science and technology policies – exemplified by the emergence of ‘systemic rationales and new typologies of innovation policies that emphasize the role of ‘indirect’ as well as traditional ‘direct’ measures, demand-sided as well as ‘supply-side’ instruments’ (Flanagan et al. 2011).

The difference between traditional industrial policy and current cluster policy is that the target group has shifted away from horizontal sectors to wider ‘value chains’, and the support mechanism has changed from direct financial support to indirect facilitation. However, in some instances, the borderline between the ‘old’ and the ‘new’ approaches is not so clear. Some even argue, that policy is currently referring back to old ways by making a selection on the type of policy being funded. Also, ‘even if the goals of cluster policy are generic, the tools used to achieve these goals often implicitly favour certain activities’ (Hospers, Desrochers & Sautet 2009, 289). Hospers, Desrochers and Sautet (2009) warn that such targeting has a long and unsuccessful history and that policy makers should pay attention to not make the same mistakes as before. Granted most cluster policies are not stand-alone support structures. This also applies to science and technology policy in general, as most initiatives are not created on a tabula rasa, but rather built on or are combined with existing policy tools. Hence, any policy related to innovative activity becomes more difficult to navigate and more complex (Pack & Saggi 2006). As Lundvall and Borras (2005) point out, the different elements of policy throughout the history of industrial policy cannot be clearly separated, instead some issues are still or again high on the current policy agenda (Pavitt 1995; Martin & Salter 1996).

In sum, cluster policy responds to the vision of innovation processes in which local interaction, networking and learning is paired with global competition and multinational companies. But challenges derive from the complexity of the innovation process and the ‘black boxing’ of stakeholder interaction and government (Flanagan et
The cluster facilitation mechanism presented in this study addresses these issues by connecting both groups and supporting collaboration, networking and learning.

1.3. Methodology and significance

Methodology

The study analyzes the impact and effectiveness of cluster facilitators in an innovative network setting at arm’s length of government. Thereby, the focus is on developments in Chicago (Illinois, USA), the Øresund Region (Denmark/ Sweden), Singapore and Vancouver (BC, Canada) in the field of biotechnology. Additional cases are included through a survey, which captures a variety of high-tech sector clusters around the world. The four cases in Europe, North America and Asia were chosen because they not only represent their respective region in terms of government involvement and cluster set-up, but also display a variation of cluster management models from strong and clearly-identified (Øresund Region) to barely any cluster management (Vancouver). The survey participants were targeted based on their membership in a cluster – with or without facilitation – to gain knowledge about the collaborative structures within a diverse set of networks. Every case and survey sample consists of government, research and industry stakeholders to capture various perspectives on cluster facilitation. This is based on the triple-helix framework (Etzkowitz 2003), which identifies interactions within the network.

The data was collected over a period of one year (2012-2013) by a combination of semi-structured interviews and an online survey. The 30 interviews were conducted face-to-face in the according cities of Copenhagen, Chicago, Singapore and Vancouver and primarily drawn from government departments, private sector companies and public research institutes or universities. Each interview took an average of one hour and consisted of questions related to the ties of the interviewee’s organization to other cluster stakeholders, the government support and funding structure, the identification of key network members and a status-quo assessment and possible improvements for clustering. The online survey, which included about 30 questions, depending on the stakeholders group the recipients belonged to, targeted 1400 stakeholders of life science, energy, ICT, environmental and manufacturing clusters around the world. The
response rate was 9.2%. Based on this response rate, the data will only be used to complement findings from the cases and picture trends rather than give conclusive results on the relationship tested.

Using the analytical frameworks of collaborative and absorptive capacity, the study identifies elements of networking relevant for performance. Based on the variables, such as strategy, communication channels or funding mechanisms, the cases reveal the inner workings of innovative clusters and how government and network management position themselves. The survey makes a connection between the presence of a cluster manager and capacity activities as well as between more capacity-enabling activities and performance. The survey includes clusters with and without facilitators and overall aims to answer the questions: Does a cluster manager create more absorptive and collaborative capacity-enhancing activities? And do more capacity-enhancing activities lead to higher performance? The case study research analyzes the complexity of cluster networking and the relationships between stakeholders, government and the facilitator. It explores the linkages between cause and effect, namely cluster management and performance levels and aims to understand the phenomena of cluster facilitation. Overall, the case study approach is able to capture the dynamics of each network in depth (Su & Hung 2009).

Significance

The study opens up the black box of cluster facilitation as a type of network management. It not only shows that a variation of facilitation approaches exists within different political systems, it further aims to fill the gap between the reality of policy and research on this subject. By studying cluster management as a government tool for enhancing innovation in clusters, the study identifies universal characteristics of facilitation based on the capacity-building framework. The analysis shows that facilitation in tandem with government occurs in a variety of high-tech sectors and always entertains a list of capacity-enhancing elements. The facilitation mechanism is embedded into the wider context of globalization. The research further includes global, European, national and regional dynamics in funding, competition and policy initiatives that affect the cluster and its facilitation.
Moreover, this study draws attention to the fact that government has to revisit its role in innovation. Instead of emulating successful clusters, it has to connect with network stakeholders and understand the needs of the industry or cluster. Further, it becomes clear that any policy in this field has to strike a balance between general versus place-based policy or indirect and direct initiatives. The cluster facilitator is the government tool that makes this connection for better policy initiatives and outcomes. Based on this, the study develops three cluster facilitation models, which include government- and stakeholder financed, an independent model and one in which the facilitator is part of government.

1.4. Uniqueness and structure

Uniqueness

The analysis of cluster and management literature shows that few, if any, studies have gathered data that could guide research or help policy makers in government understand when cluster collaborations make sense or how to design and implement them (6 et al. 2006). The literature is not only struggling with defining clusters and cluster policy properly, but also with how to capture the dynamics going on within networks, such as knowledge spill-over, learning and global collaborations. In fact, in some aspects, policy – especially in Europe – is ahead of the empirical evidence (Brakman & van Marrewijk 2013). As Leven, Holmstroem and Mathiassen (2013) point out, there is little known about the challenges associated with managing innovation in specific networks and involving interdisciplinary research. A solution to these challenges is thinking about the elements that create possible learning environments, such as networking among a certain group of people and regular communication channels while incorporating entry-points for government support. To conceptualize the dynamics going on within cluster networks and their connections to outside knowledge sources, the study transforms the firm-based concepts of collaborative (Lai 2011) and absorptive capacity (Cohen & Levinthal 1990; Bell & Albu 1999; Narula 2004, Giuliani 2005) and makes them applicable to the cluster environment.

The study further puts the systems of innovation approach (Edquist 1997, 2005) into a learning context. The learning lens allows analyzing patterns of continuity and
change within and across networks (Bradford & Wolfe 2013). It further highlights the fact that learning is not only an integral part of innovative processes, but also crucial for policy-makers to design initiatives in support of learning (Koschatzky 2009). In addition, cluster policy is seen as a place-based approach to innovation. By looking at cluster policy from a place-based perspective, unique spatial challenges are combined with various levels of government. Place-based policy sets out to address those challenges by looking for a locally or regionally tailored, broadly integrative, collaborative governance arrangement (Karkkainen 2004). In essence, the place-based approach has two fundamental aspects to it: First, it emphasizes the importance of a place or geographic context, which refers to social, cultural and institutional characteristics (Barca, McCann and Rodriguez-Pose 2012). And second, place-based policy acknowledges various levels of government and the different policy layers involved. In contrast, place-neutral or aspatial policies pay less attention to locality based on the premise that policy should be built around the special agglomerations at local and regional level (Barca, McCann and Rodriguez-Pose 2012).

Overall, the study contributes to a limited selection of academic material that systematically analyzes the effectiveness of cluster policy and possible tools for enhancing innovative performance and ultimately economic competitiveness. It addresses the main challenges that come out of the current innovation literature, including:

- the conflict between local and global dynamics
- the frameworks of clusters, regional and national innovation systems being proxies for knowledge-transfer and learning
- finding the right policy tools to enhance innovative performance for competitiveness.

**Structure**

The study is structured according to the following format: the next chapter (Chapter 2) provides a literature review on clusters as networks in general, (public) network management, the collaborative and absorptive capacity framework and the challenges of high-tech industries. It specifically explains the effects of clustering in
terms of networking and learning, why location remains important in a globalized economy and finally develops a framework for conceptualizing cluster facilitation based on capacity-building. Chapter 3 outlines the research methodology for both, the case studies and the survey. It contains a discussion on the advantages and disadvantages of each method and gives a detailed outline of case selection, choosing interview partners and how the questions were developed and phrased. Chapter 4 summarizes the survey data. It looks at the characteristics of cluster managers and their evaluation by stakeholders. The self-reporting by survey participants also gives insight into the role of government and ultimately into the effects of cluster management on performance. Chapter 5 is dedicated to the case studies. The order of the cases is based on the degree of leadership in the network, starting with strong to weak – Medicon Valley, Chicago, Singapore and Vancouver. The presentation of each case is similar, starting out with a general introduction of the key players, such as government departments and the cluster manager, followed by a more detailed assessment of the elements of the collaborative and absorptive capacity framework. Each cluster analysis also includes an outline on what the current struggles are and the key questions related to that specific set-up. Chapter 6 compares the cases based on performance data, such as patent share and employment numbers as well as the compiled evidence for the existence of the capacity characteristics. It further reflects upon the case study and survey findings, while Chapter 7 sums up the entire study and reflects on the connection between those findings and implications for policy.
2. Literature review

2.1. Industry clusters

The more common use of the cluster framework is based on the assumption that knowledge production and spills drive successful innovation, which in turn is influenced by geographic proximity (Torre 2006). Thus, clusters are associated with locality, proximity and different types of cooperation between institutions (Dohse 2007). However, over the years and in tandem with innovation research, clusters theories have moved beyond the idea of strict locality. In addition to the geographical scale, global networking has become part of clustering. Further, the aspects of knowledge transfer (especially tacit knowledge) and the policy perspective (networking policy) have gained importance in addressing different types, sizes and dynamics of clusters. Explanations for clustering range from the ‘industrial district’ (Marshall 1920) to the ‘Silicon Valley Model’ (Saxenian 1994), varying in their definition of constituting parts and interactions as well as possible boundaries. Thereby, endogenous and exogenous factors also play a role in the literature.

The idea of a cluster or rather of a localized industrial development originates in Europe: Marshall (1920) identifies ‘industrial districts’ as ‘local availability of inputs, presence of a skilled labour force and knowledge spillover’ (Giuliani 2005, 270). In his research, Marshall mainly describes the metallurgical and textile-producing areas of Great Britain. Almost 60 years later, Becattini (1979) highlights the similarities between this British industry and certain areas in Italy. He refers to the Marshallian industrial district as a localized social and productive ‘thickening’, held together by a ‘complex and tangled web of external economies and diseconomies, of joint and associated costs, of historical and cultural vestiges, which envelops both inter-firm and interpersonal relationships’ (Becattini 1979, 132 in: Goodman, Bamford & Saynor 1989).
While these definitions emphasize the geographical proximity, other scholars add to this by paying special attention to social and cultural aspects related to clustering. Rosenfeld (1997) for example points out that clusters should have active channels for business transactions, dialogue and communication. ‘Without active channels even a critical mass of related firms is not a local production or social system and therefore does not operate as a cluster’ (Rosenfeld 1997, 10). This is similar to the working definition used by the ‘European Cluster Observatory’\(^3\), which states that:

We advocate the use of narrow and precise definitions of central analytical concepts as tools in empirical studies and as a basis for policy-making. Thus, we are in favour of restricting regional clusters to geographical concentrations of interconnected firms, and use the concept regional innovation system to denote regional clusters plus ‘supporting’ institutions. To constitute an innovation system firms in a regional cluster first have to form regional innovative networks involving more organised and formal co-operation between firms in innovation projects. Then for example suppliers not only produce components or modules to customers’ specifications but also co-operate with their customers in developing new products. The focus on innovative networks corresponds with the emphasis in OECD (2001b) on how enterprise clusters stimulate firms’ innovation process by the flow of ideas, information and knowledge within clusters. (European Commission 2002, 14)

The European definition includes 1) the role of the geographic proximity; 2) the levels of analysis and 3) the understanding of knowledge flow. The phrasing of the geographic issue in terms of innovative networks and the inclusion of ‘supporting’ institutions provides the opportunity to include global linkages and gives the definition a certain degree of flexibility. In comparison, Porter’s well-known definition limits the cluster connection to a single nation or state. He states that ‘geographic concentrations of interconnected companies and institutions in a particular field’ (Porter 1998, 78) define a cluster. Porter further concludes that ‘the process of clustering […] works best when the industries involved are geographically concentrated’ (Porter 1990, 157). Further, the

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\(^3\) The European Cluster Observatory offers a quantitative analysis of business clusters across all EU countries based on a fully comparable and consistent methodology. The purpose of the observatory is to inform policy makers, cluster practitioners and researchers, throughout the world about European clusters, cluster policies and cluster initiatives. Beyond cluster mapping, the European Cluster Observatory provides information about policies and programmes relating to clusters. In addition, it includes a comprehensive database and mapping of cluster organisations. (European Commission Website 2010)
levels and tools of analysis outlined by the European Commission are more specific: regional clusters are distinguished from regional innovation networks and the regional innovation system. The cluster is the smallest unit where firm relations are concentrated. On a higher level of analysis, the term ‘regional innovation network’ describes organized cooperation. Characteristics such as stimulated trust, norms and conventions reveal that at this level social capital is suspected to play a role. The ‘regional innovation system’ (Cooke et al. 1997, Braczyk et al. 1998, Asheim & Isaksen 2002), as the highest level in this definition, describes the relationship between firms and other organizations for knowledge diffusion.

In the innovation literature, the latter two levels – regional innovation network and regional innovation system – are combined. The so-called ‘regionally networked innovation system’ (Asheim & Gertler 2005, 301) is commonly regarded as the ideal type of a regional innovation system: ‘a regional cluster of firms surrounded by a regional ‘supporting’ institutional infrastructure’ (Asheim & Gertler 2005, 301). However, the concept of regional innovation systems in general has been called into question by those emphasizing global knowledge networks flows as well as the fact that ‘firms clustered in particular areas require access to non-local sources of knowledge as an essential complement to the knowledge they generate and share locally’ (Asheim & Gertler 2005, 310). This issue has been resolved in the definition brought forward by the European Cluster Observatory by allowing – as mentioned above – for the possibility of global linkages.

The last aspect addressed in the above quoted cluster definition is the understanding of knowledge diffusion. The document by the European Commission further states on this that: ‘Communication that contains flows of non-codified knowledge, and which is complex and uncertain, frequently involves dense human relations, which in turn are stimulated by proximity between individuals, firms, and organisations’ (European Commission 2002, 15). This adds a crucial dimension in terms of cluster development and success. ‘Non-codified knowledge’ or ‘tacit knowledge’ (Lundvall 2001, 279) is essential for the strength of a network, as it defines the ‘competitive advantage’ given by proximity. Tacit knowledge can only be learned through experience and thus requires interaction and imitation as well as cooperation (Lundvall 2001). This is closely linked to the concept of social capital, which is defined as the
social capability of citizens and workers to collaborate and share knowledge and information without too much friction (Lundvall & Archibugi 2001, 5).

Overall the European understanding of clusters is similar to the ‘Silicon Valley Model’ (Saxenian 1994; Kenney 2000), which is characterized as:

[A] regional-network-based industrial system – that is, it promotes collective learning and flexible adjustment among companies that make specialty products within a broad range of related technologies. The region’s dense social networks and open labor market encourage entrepreneurship and experimentation. Companies compete intensely while learning from one another about changing markets and technologies through informal communication and collaboration. In a network-based system, the organizational boundaries within companies are porous, as are the boundaries between companies themselves and between companies and local institutions such as trade associations and universities. (Saxenian 1994, 25)

Similarities especially occur in the idea of informal communication as well as the ties between different levels of operation. However, some European scholars even go further and claim that – regarding the example of the European Nordic telecommunication sector – the trajectory is much more complex, with clusters developing on at least two levels (Berggren & Laestadius 2003). The sector example reveals that there is a co-development ongoing which manifests itself in local clusters and in supranational (mostly bi-national) networks. Further, Berggren and Laestadius (2003) emphasize the importance of public policy as well as public-private partnerships.

Generally, many authors still criticize the ‘fuzziness’ of the cluster concept and its definition (see for example Held 1996; Steiner 1998; Martin & Sunley 2003). However, in recent years, the literature was able to further define the cluster by setting it apart from the general network term as well as science and industrial parks. The term ‘network’ refers to a group of stakeholders that cooperate on a joint project – complementing each other and specializing in order to overcome common problems, achieve collective efficiency and conquer markets beyond their individual reach. The term ‘cluster’ is used to indicate a sectoral and geographical concentration of enterprises which produce and

\(^4\) However, while the network term is of broader scope and clusters emphasize the geographic proximity of stakeholders, both terms are used interchangeably throughout the study.
sell a range of related or complementary products and are, thus, faced with common challenges and opportunities. As the European Commission (2012a) points out:

Clusters and networks share some common features. Conceptually, both are located between the atomistic structure of an uncoordinated market and the organic structure of a vertical hierarchy. Firms within networks and clusters are linked by something more than the price mechanism of the market. (Ibid, 225)

However, cluster and networks have different policy implications, mainly due to the spatial concentration of clusters and the wider spread of networks. The networks literature is not so much concerned with the concentration of firms in particular areas, but rather with the process that leads individual firms to establish cooperative links with each other, even if they operate in different regions. In contrast, the basic assumption about clusters is that there is geographic proximity involved in the relationship among stakeholders. Raab and Kenis (2009) develop two categories of networks, which fit the cluster idea. They distinguish between ‘networks an sich’ (networks in itself), which do not develop a collective identity versus consciously created, goal-directed networks, called ‘networks fuer sich’ (networks for itself). Clusters fall into the latter category by purposefully creating proximity and ties to reach the goal of greater competitiveness. Raab and Kenis (2009) predict that the ‘networks fuer sich’ represent a new organizational form that will become dominant in the future, replacing the formal hierarchical organization of the 20th century. Key structural proponents of this type of network include the focus on the network as a whole (centrality), the uniqueness in comparison to other networks (distinctiveness) and more or less enduring character (continuity) (Rometsch & Sydow 2007).

Another body of literature focuses on policy networks. This type of collaboration ranges along a spectrum of ‘iron triangles’, which include interest groups, congressional committees and government agencies (Cater 1964) to so-called ‘issue networks’, which are much less stable with a constant turnover of participants (Heclo 1974; Howlett, Ramesh & Perl 2009). Based on Rhode’s typology of networks along this continuum, clusters fit in on the loose end, the issue networks. This has to do with the fact that members do share common interests in the network and are interdependent to a certain degree, however, the cluster is not isolated from other networks. Also, the resource distribution varies depending on the amount of government funding and external
investors. The policy network literature further raises the issue of a ‘hollow core’ in certain set-ups (Salisbury et al. 1987; Heinz et al. 1990), which also applies to clusters. It is argued that some policy networks lack actors that stand in the centre of the system and have the ability to shape winning coalitions. However, often times networks are reluctant to have one leader in the network, but need a mechanism to overcome possible free-rider problems or the ‘weakness of loose ties’ (Orton & Weick 1990). Overcoming this dilemma is mostly done by building trust and substituting missing hierarchical governance elements with community-level coordination (Urbaniec and Gerstlberger, 2011).

Another term that has been widely used in recent years, especially in connection to innovation and technological development is the ‘industrial park’. This concept refers to an area zoned and planned for the purpose of industrial development. Within that zone a science park could be established, which is defined as an area with an agglomeration of institutions dedicated to scientific research. ‘If this research is dedicated to commercialization of inventions, the area may be called a technology park’ (Mroczowski 2012, 194). From the basis of a science park, a cluster could evolve if there are brokers that connect researchers to a larger network of companies and institutions in the field (Bradford & Wolfe 2013). This is one starting point for a cluster. Others might be that an original innovation is at the heart of a network that has grown locally and created a cluster over time. In other words, ‘just as a cluster may ‘cause’ innovation, an original innovation may create a cluster’ (Mroczowski 2012, 197). Also, a previous set-up makes an area conducive for the development of a cluster – with or without government support. As Feldman & Florida (1994) point out, the ‘capacity to innovate is very much the historical legacy of specialized concentrations of R&D, industrial activity, and support services that build up in particular places over time’ (226). Even if the industry was completely unrelated to high-tech in general, every innovation depends on a set of underlying factors that comprise a technological infrastructure for generating new ideas and bringing them to the market.

**New regionalism literature**

The new regionalism literature, similar to the cluster framework, also pays special attention to local networks. While earlier studies extensively glorify the local dimension of
agglomerations, a ‘relational turn’ led to recognizing the dynamic of local structures within a global framework (Yueng 2010). The new regionalism research draws upon the cluster examples of Silicon Valley in California or the Third Italy to highlight the importance of local agglomerations and institutional structures as necessary and sufficient conditions for regional growth (Scott and Storper 2003; Howells 2005; Lagendijk 2006; Harrison 2007; Yueng 2010). After a call for an extension of the analytical focus ‘from a boundary territorial system of production to an unbounded, scalar spatial system in which both local and international relations are taken into account’ (Hadjimichalis 2006, 102-103), the research started incorporating the global production network and its competitive dynamics.

Like cluster theory, this research strand started to think about the competitive advantage of certain locations and the role of government in enhancing those assets. The new regionalism approach further points towards the competition for lower costs, flexibility and speed by saying that firms – especially in high-tech sectors – are past the point where they only look for low-cost production locations, but rather for an organizational and technological fix. This implies that firms are looking for set-ups in which stakeholders with a common strategic objective unite and specialize in a certain area to become more successful, efficient and flexible towards change (Yueng 2010).

Overall, clusters reflect the fundamental influence of linkages across firms and associated institutions in competition. This challenges an economy to move from isolated firms to more advanced interconnected activities. Economic development becomes a collaborative process involving government at multiple levels, companies and research institutions. These changes require sustained participation by all actors as well as leadership by a committed individual to create momentum and integrate individual constituencies into a common upgrading process (Porter 2003). The general expectation is that clustering has a positive effect for the firms located within it and ultimately affects the competitiveness of the whole region and also gives access to employees, suppliers, specialized information and institutions (Aylward & Glynn 2006, Dana & Winstone 2008). But the formation and sustaining of networking structures bear some initial and ongoing costs. In the formation phase, for example, stakeholders often bear short-term costs for long-term results. Building a strong collaboration, which benefits diverse actors within the cluster is costly and might only pay off months or even
years later. Thus, successful clusters need long-term group members that are committed to the idea of cooperation and communicating to reach a common goal.

The current assessment of the cluster set-up suggests that there is a shift towards more equal partners in the network and a need for sustainable management to guide it. The organizational structure that finally evolves will often be a meso one, between the private and public sectors.

Options for the meso organization range from stand alone, membership organizations (with annual membership fees covering as a minimum the administrative costs of the organization), and an economic development agency offering office space and seconding a staff member to act in the long term as the ‘Cluster Facilitator’. (Ffowcs-Williams 200, 195)

The aspect of active cluster management is often overlooked as existing studies model only firms in the cluster, ignoring both ties between cluster members and other firms (Harrison 1994, and Saxenian 1994, are notable exceptions) and the overall industry network structure (Storper and Harrison 1991). Focusing on these ties, Bell (2005) points out that firms and their executives in a cluster are part of two types of networks: First, a managerial network of informal ties among stakeholders and second, an institutional network of formal ties between firms. Thereby, the managerial network, which would be facilitated by a cluster manager, enhances the flow of information and tacit knowledge (Uzzi 1996). Bell (2005) further states that the position of a firm or manager affects innovation. He states that the centrality of a firm in a cluster or network enhances its innovation due to access and information. Here, a facilitator can enhance these characteristics for several firms by making information available and being the access point for different platforms. Simply aggregating cluster and network mechanisms into ‘cluster effects’ (Bianchi & Bellini 1991) thus confounds benefits related to clustering per se with benefits arising from network ties. In sum, Bell’s (2005) study shows the importance of examining cluster effects in greater detail, clearly differentiating between mechanisms that drive performance. The aspect of centrality makes clear that different actors can occupy different role positions and carry different weight, creating unequal opportunity contexts and filling ‘structural holes’ (Burt 1992), whereas others may be less willing or able players (Agranoff 2006).
The review of the network and cluster literature highlights several important aspects. First, networks come in various forms and shapes and are thus governed differently (Provan & Kenis 2007). This issue is a key assumption for the following discussion on the type of network management for clusters. Second, various research traditions and tools have to be used in order to examine clusters in depth and in a complete way (6 et al. 2006). And third, the different types of collaborations and the involvement of different actors are complex and defy easy generalization. As the analysis of management aspects of networking will show, few, if any, studies have gathered data that could guide research or help policy makers in government understand when cluster collaborations make sense or how to design and implement them (6 et al. 2006). In addition to these concluding remarks on network and cluster theory, the focus on clusters specifically can help to break down some of the complexity that comes with network analysis, by defining pre-conditions, dynamics and limits of industry clusters in terms of government policy, management and competitiveness. It also shows that a cluster has, due to its voluntary collaboration and common purpose, favorable conditions for implementing a facilitator as the later section on network management will show. The implications of clustering so far include the exchange of (tacit) knowledge through collaboration and profiting from the local set-up of companies and research institutions. This is paired with the expectation that clustering leads to higher levels of productivity, innovation and employment.

As of now, both, the cluster literature and the new regionalism research only mention cluster policy in passing. Either because it is part of a more general approach to science and technology or not recognized as a separate policy field at all. This also has to do with the fact that clusters have become quite popular in the practical application arenas of policy, but less so in the academic fields.

2.1.1. Cluster policy as a place-based approach

There are two opposing approaches to cluster policy. First, Porter’s idea of an economic or evolutionary view suggests that market forces regulate the dynamics and ultimately the output of a cluster. Basically, policy has the role of investing into the infrastructure around the cluster – for example education – to create resources for stakeholders. In contrast, the constructive view sees government as the main initiator of
cluster formation, financing and regulating the cooperation among stakeholders and fostering competition. The constructive view thus focuses on policy, which includes programs directly targeting the cluster (Sölvell 2008, 126). Problematic is the level of analysis both approaches use. The economic view incorporates measurements from the national down to the firm-level. The constructive view also includes cluster stakeholders, but because the whole cluster is seen as an economic tool, there is less attention paid to the individual level and thus to networking dynamics. This study looks at cluster policy from a place-based perspective, in which unique spatial challenges are combined with various levels of government. Along the continuum of distant policy decisions that affect framework conditions and targeted cluster policy, this approach lies at the tailored end of initiatives while keeping all levels of government in mind.

The ‘placed-based approach’ (PBA) includes ‘territorially grounded policies that are multi-level in their governance structure and tailored to the reality of individual regions’ (Wolfe 2011, 1). In essence, the place-based approach has two fundamental aspects to it: First, it emphasizes the importance of a place or geographic context, which refers to social, cultural and institutional characteristics (Barca, McCann & Rodriguez-Pose 2012). And second, place-based policy acknowledges the various levels of government and the different policy layers involved. In contrast, place-neutral or aspatial policies pay less attention to locality based on the premise that policy should be built around ‘mobility, agglomeration and thus, the promotion of specific urban sectors or technologies with little or no recourse to the regional context’ (Barca, McCann and Rodriguez-Pose 2012, 140). This disregards the notion that even space-neutral policies will always have explicit spatial effects, many of which will undermine the goals of the policy itself unless its special effects are taken into account. Placed-based policy can address at least some of these obstacles by attempting to influence the future trajectories of a place and recognizing local autonomy while being attentive to the national interest (Castle & Weber 2006). However, not every policy can be place-based and there are also many aspatial public policies with unintentional place-based implications. This shows that space-neutral and place-specific initiatives have to coordinate their primary focus with other policy areas and different levels of government (Wolfe 201; Barca, McCann & Rodriguez-Pose 2012). As Wolfe (2011) puts it, a move towards a place-based policy at the regional levels ‘requires a new approach to the
governance mechanisms for policy development that incorporate regional exercises to identify and cultivate their assets, undertake collaborative processes to plan and implement change, and encourage a regional mindset that fosters growth’ (Ibid, 2).

Place-based policy spans everything from global and European to city measures. Thus, ‘attention directed to intermediate decision-making and local government does not diminish the need for, or the importance of, federal and state government’ (Castle & Weber 2006, 11). The national level is responsible to set boundary conditions that address the national interest in specific places while also providing resources, based on which local governments are able to develop community agendas and tap into information from other jurisdictions. Further, local autonomy caters towards place-based needs and allows putting national resources into use in ways that appear most beneficial to those directly affected (Castle & Weber 2006). However, the model of distributed responsibilities along government levels is often much more complex in practice, as policies become layered and incoherent.

Due to the complexity and uncertainty of innovative processes, traditional administrative practices are becoming more and more outdated (Lafferty & Meadowcroft 1996; Innes et al. 1994). Conventional policy instruments are now part of a much richer mixed strategy and are often neither the driving force nor the defining characteristic of governance arrangements anymore. Instead, there is a variety of instruments such as voluntary commitments and quasi-contractual cooperative agreements (Karkkainen 2004). Further, upper-level governments have passed down responsibility to municipal authorities to address more localized issues (Bradford 2004). These developments can lead to a mismatch between municipal responsibilities and the policy resources available, incoherence between national-level policies and local action as well as layering of instruments and policy goals. This leads to incoherence in goals and instruments and thus to suboptimal development paths (Kern & Howlett 2009). The problem of layering is present in most science and technology policies, due to the different levels of government involved. Mixing policy instruments, however, makes the already complex issue of innovation even more complex, because in most cases, existing regulation – such as federal regulative instruments – cannot be abolished before ‘new’ strategies are applied by other orders or levels of government. Thus, national rules remain the backdrop for anything that is done at the global, regional or local level.
Place-based policy sets out to address those challenges by looking for a locally or regionally tailored, broadly integrative, collaborative governance arrangement (Karkkainen 2004). In other words, addressing place-related implications of policies that do not have places as primary focus, and emphasizing local autonomy while being attentive to the national interest. Ultimately, there must be some overlap among place, community and (local) government (Castle & Weber 2006). Thus, framing cluster policy in a place-based perspective helps to provide a more comprehensive view of a region’s needs instead of solely focusing on emulating successful examples. It also draws attention to the fact that clusters are local, but are also embedded in a larger system of national and regional innovation systems.

The view of treating spatially-focused or cluster policies as embedded within a larger system of national interest and local autonomy ties into the discussion of the importance of ‘place’ in an increasingly global world.

2.1.2. The paradox of location in a global economy

Even though today’s economy is globalized, the literature keeps coming back to the fact that innovation is tightly clustered in a small number of major centres. As Asheim and Gertler (2005) put it, ‘geography is fundamental, not incidental’ (Ibid, 292). This implies that not only is innovation found in spatial agglomerations, but that the location also impacts the innovative activities. This is the premise the cluster concept is predominantly based on: the idea that the competitive advantages in a global economy lies increasingly in local things – knowledge, relationships, motivation (Porter 1998). This paradox of location in a global economy can be explained based on the advantages of proximity, which include the exchange of tacit knowledge and the combination of cooperation and competition. Obviously tacit knowledge and cooperation go hand-in-hand as this type of knowledge is defined as something which can only be experienced and transferred face-to-face. The exchange of such knowledge is what sets clusters apart, as learning-by-interacting is difficult to emulate and gives the network its competitive advantage over other regions. Further, innovation is increasingly based on the interactions and knowledge flows between entities, such as research institutions, universities and companies (Asheim & Gertler 2005). Hence, the circulation of tacit knowledge through collaboration make up half the argument for spatial agglomeration.
The other part is the competition among stakeholders in one space. As the Danish study by Lundvall and Christensen (2003) shows, increased competition will lead to more product innovations and the creation of new markets. Further, competition ‘puts a premium on skills to cope with change and to interact with others in coping with change’ (Lundvall & Christensen 2003, 21).

A predominantly spatial analysis of local networks is also captured in the systems of innovation approach, in which clusters are the smallest entity compared to the national and regional innovation system. Basically, each country has some form of national innovation system, which consists of a variety of regional innovation systems that sometimes cross national boundaries. Within those regional innovation systems, universities and companies can then cluster in a particular locale. Thus, widely divergent regional innovation systems can and do emerge within a single national institutional framework and the same is true for more localized clustering of stakeholders within those regions (Asheim & Gertler 2005). The systems of innovation approach (SI) defines ‘all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations’ (Edquist 1997b, 14; Edquist 2005). However, it is difficult to define boundaries within the SI approach. The questions remains, if the distinction between what is inside and outside the system is based on geography, industry sectors or other factors. In the national innovation system, a natural boundary is the country’s geography, but regional innovation systems and clusters often reach across borders. Relying on a technology or research field for determining the boundaries is also tricky, because research is often interdisciplinary and spans a wide variety of stakeholders. Geography is even more challenging, as regional networks might span two or more countries and may include other global players. Asheim and Gertler (2005) further distinguish between different types of regional innovation systems. The first ones are territorially embedded regional innovation systems, which include for example industrial districts. Second, regionally networked innovation systems, which have a planned character, as they are strategically set up locally and at the same time gain access to wider pools of knowledge globally. The third type are regionalized national innovation systems in which exogenous actors and relationships play a larger role. This would include science parks and technology parks.
In sum, while the regional innovation system and cluster approach identify the specific circumstances for innovation, the national innovation system looks at the larger, more basic factors. Both perspectives are based on the belief that innovation is determined to a considerable extent by the innovation system’s circumstances and government policies contributing to them. Today, most modern regional innovation policy is designed to counter or overcome both the market failures and system failures associated with both insufficient knowledge exchanges and also institutional weaknesses, which are either partly due to problems of economic geography or partly manifested in terms of economic geography. (McCann & Ortega-Argiles 2013, 197)

Thereby the innovation system approach is the underlying logic for the design of some of the policies.

The danger of cutting up innovation processes into national, regional and spatial clustering dynamics is that it might overlook the multi-level character of innovation and policy. The multi-level perspective pays special attention to the interdependencies between supra-national, national, regional and local levels of policy-making. All spatial levels are seen as relevant to scientific research activities and innovation processes, and they are connected through different levels of regulations and interactions of policy-making processes. In this process each level pursues own goals and policies, which are related to the overall system. The multi-level concept gained ground in recent years and is ‘shifting attention towards the interrelationships between administrative levels in a multilayered context’ (Sotarauta & Kautonen 2007, 1088). The definition from Hooghe and Marks (2003), which initially described multi-level governance as a ‘system of continuous negotiation among nested governments at several territorial tiers – supranational, national, regional and local’ (Ibid, 3) is now used more broadly to include all components that are connected to innovation. The multi-level perspective is mostly applied in an EU context where the system is characterized as having (1) shared decision-making competences; (2) being non-hierarchical and (3) non-majoritarian. These components together form a governance pattern that is highly dynamic (Kaiser & Prange 2002) and varies over time and across policy areas (Kohler-Koch 1999). All in all, the multi-level understanding of the EU gives insight into the interrelations of
competences and also the links between different issues, as ‘political arenas are interconnected rather than nested’ (Marks et al. 1996, p.346).

While the multi-level governance approach shifts attention towards interrelations across levels (Sotarauta & Kautonen 2007), it has come under scrutiny for lacking analytical tools and for simply referring to different administrative levels and structures of policies (Bache & Flinders 2004; Kitagawa 2005; Sotarauta & Kautonen 2007). Further critiques point towards the adoption of a strong top-down perspective and the fact that insufficient sensitivity is shown towards ‘the temporal dimension of the multi-level governance of science and innovation’ (Börzel 1998; Perry 2007; Sotarauta & Kautonen 2007, 1088). All in all, it can be said that this approach sometimes lacks the explanatory power (Börzel 1998), but helps to identify some of the complexity of science and technology policy by naming the levels involved in framing innovation.

In sum, there are a variety of ways to frame innovation processes in terms of spatial or administrative dimensions. However, the question remains if these frameworks are only proxies for the knowledge spill-over and learning dynamics going on between stakeholders. The learning lens captures these types of interactions.

### 2.1.3. Learning within network structures

The learning lens allows analyzing patterns of continuity and change within and across networks (Bradford & Wolfe 2013). It further highlights the fact that learning is not only an integral part of innovative processes, but also crucial for policy-makers to design initiatives that support the network – for example by learning from ‘past experiences, ongoing implementation processes and the assessment of future trends’ (Koschatzky 2009, 3). What is learned, in other words, the type of knowledge accumulated, also determines what will be done with new information (Howlett, Ramesh & Perl 2009). This aspect of learning is closely linked to the capacity of the network to absorb new information, exchange tacit knowledge and communicate what was learned to other stakeholders. Another facet to learning is the question of where knowledge is located and how it can be transferred. For example, Belussi and Sedita (2010) distinguish between local learning and a global pipeline of knowledge. Local learning includes the transfer of knowledge between network members in a certain location. Non-local
learning describes the ability of stakeholders to learn from outside sources or even substitute a lack of local learning with global knowledge transfer. Examples of this have been observed in some up-and-coming high-tech clusters in Asia, where foreign direct investment and the general involvement of multi-national companies led to knowledge gains and ultimately higher innovative output in the local community.

The learning concept, in relation to clusters, has evolved since the first idea of clustering based on Marshall (1920). Whereas early researchers focused solely on the localized learning effects of clustering, today, there is much more research about the interdependencies between local and distant learning. Table 1 tracks some of that evolution of the learning concept from localized learning to distance learning based on the main contributors and key concepts. It shows that the cluster concept, which is prominently connected to Porter’s idea, is categorized as modern view with a local focus. However, going back to the definition used by the European Commission and the dynamics to clustering today, the understanding of learning in clusters has also evolved. This is especially visible in the ‘absorptive capacity’ framework, which will be discussed in more detail in Section 2.2.1. The concept distinguishes between intra- and extra-cluster knowledge in which the existing intra-cluster knowledge determines what is learned and incorporated from extra-cluster sources. It further defines three components of this learning process, exploratory learning, transformative learning and exploitative learning. These are connected, as exploratory learning describes the confrontation with new knowledge, transformative learning changes the way in which this knowledge is assimilated and combined with prior knowledge, while explorative learning describes how new knowledge is translated into action, which will ultimately benefit the organization or network (Buenstorf and Murmann 2005; Lane et al. 2006; Harvey et al. 2010). This goes beyond the localized cluster set-up to highlight the connections with sources outside of a region to gain more knowledge and additional learning opportunities. The pro-active approach of going out to find those sources that complement localized knowledge is matched by the above-mentioned theory that says that international investors bring a set of knowledge that is useful to cluster members locally.
<table>
<thead>
<tr>
<th>Prevalent type of learning</th>
<th>Main contributions</th>
<th>Key concepts</th>
</tr>
</thead>
</table>
| **Localized learning**    | The Marshallian heritage | Marshall (1920) | Elements involved with the formation of ‘districtualization’ giving rise to localized external economies:  
1. Pooling of skilled workers  
2. Ancillary industries and specific infrastructures  
3. Firm specialization  
4. Constructive cooperation  
5. ‘Industrial atmosphere’ which favours knowledge transmission |
|                           | The modern view | Porter (1998)  
Saxenian (1994)  
Scott (2006)  
Storper (1997)  
Feldman (2006)  
Bellandi (1992) | The discovering of industrial districts as local innovation systems |
| **Distance Learning**     | The global perspective | Amin and Thrift (1992)  
Scott (1992) | Local nodes in global networks  
The world economy as a mosaic of regions consisting of localized networks of transactions embedded in global networks |
|                           | Industrial districts as open evolving systems | Coro and Grandinetti (1999)  
Belussi and Gottardi (2000)  
Belussi and Pilotti (2002)  
Moodysson, Coenen and Asheim (2008)  
Saxenian (1999, 2006)  
Coe and Bunnell (2003)  
Andersen and Lorenzen (2005)  
Hsu (2003)  
Bathelt, Malmberg and Maskell (2004)  
Humphrey and Schmitz (2002) | Local systems with absorbing capabilities of external knowledge |
Using the learning concept as an analytical tool however can also be challenging for two reasons. First, it is difficult to conceptualize learning in a way that would make it quantifiable and measurable. Learning can take all kinds of forms and the information or knowledge exchanged might not always be useful to the receiver. Also, are stakeholders learning the ‘right’ things? Meaning that if stakeholders lack the capacity to pick the information they need to move forward in their development, learning ultimately has little to no effect. In terms of measuring learning, as Bennett and Howlett (1992) suggest, one possibility is to identify change – the hypothesized effect of learning. However, this brings a whole new set of problems, taking into account that ‘positive’ change in a network environment, such as the one of a cluster, means different things to different stakeholders. While a change in policy tools might be easier to track, change in a research institute could be as small as a slight variation in the field they focus on or the number of patents they apply for, which still does not say anything about the success of that stakeholder in the innovative process as a whole. The second challenge is the question of how to enhance learning. Since learning is such an important part of the innovative processes going on in clusters, policy-makers have, in recent years, started to target knowledge-transfer processes directly. They are not confined anymore to ‘a more or less limited range of actions aimed at leveraging the complexity, codification and specialization of clustered firms’ (Caloffi 2010, 289), but were extended to a wide range of supporting collective processes of learning and innovation (Belussi 1999; Mytelka 2000). However, this could include many different policy initiatives and without the proper tools to assess their effectiveness, enhancing learning processes remains tricky.
2.2. **Systematically conceptualizing cluster dynamics for policy**

The discussion shows that the literature is not only struggling with defining cluster and cluster policy properly, but also with how to capture the dynamics going on within networks, such as knowledge spill-over, learning and global collaborations. It further highlights the fact that in some aspects, policy – especially in Europe – is ahead of the empirical evidence (Brakman & van Marrewijk 2013). This gap between policy and academia is problematic in several ways. It basically implies that practitioners are left in the dark about the effectiveness and efficiency of their policy instruments. A closer look at government’s efforts in supporting clusters shows that in many cases the attempt to create or support a cluster results in failure. An example for this is New Jersey’s attempt to create a Silicon Valley high-tech sector, which eventually led to a limited research consortium (Leslie & Kargon 1997; Feldman & Francis 2004). There are also examples of success such as the Biotechnology clusters in Boston or San Diego. Those different experiences in cluster performance led researchers to the conclusion that there are unique factors associated with each success or failure. As Feldman and Francis (2004) put it, clusters have ‘signature characteristics’ (Ibid, 130) that lead them to develop certain infrastructure, industrial activity and the possibility of venture capital. By attributing the success of some clusters and the failure of others to unique characteristics in each location, research has come no step closer to finding systematic ways to supporting clustering and the innovative processes ideally going on within them. This is one of the reasons for the surge in documents by consulting agencies such as Ernst & Young or PricewaterhouseCoopers that analyze and attempt to measure cluster policy (see for example Ernst & Young 2008, 2011; PwC 2011). The European Union
has also been active in this field by developing policy documents and launching the ‘Cluster Mapping Project’\(^5\).

In this dearth of academic material that systematically analyzes the effectiveness of cluster policy and possible tools for enhancing innovative performance and ultimately economic competitiveness, this study addresses the main challenges that come out of the current innovation literature, including:

- the conflict between local and global dynamics
- the frameworks of clusters, regional and national innovation systems being proxies for knowledge-transfer and learning
- finding the right policy tools to enhance innovative performance for competitiveness.

To address these challenges, the study focuses on elements that create possible learning environments, such as networking among a certain group of people and regular communication channels while incorporating entry-points for government support. The analysis transforms the firm-based concepts of collaborative and absorptive capacity and makes them applicable to the cluster environment in order to conceptualize the dynamics going on within cluster networks and their connections to outside knowledge sources. These two frameworks identify elements that enhance the knowledge-transfer in networks. For collaborative capacity, these include, for example, policy documents laying out the means and goals of the network, communication channels or funding schemes. Absorptive capacity is connected to the ability to pick and choose the right knowledge that fills a gap within the cluster and use it properly for best innovation results.

Adding to this framework, this study hypothesizes that there needs to be a management or facilitator position that is a central node within the network and simultaneously at arm’s length of government to enhance innovation and

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\(^5\) As part of the Europe INNOVA Cluster Mapping Project, a comprehensive mapping of cluster policies, cluster institutions and cluster programmes in 31 European Countries is currently under way. The Cluster Mapping tool aims to give access to an advanced data set on clusters and regions in Europe. It provides statistical information from a wide range of sources, both on the geographic concentration of various industries and indicators of economic performance. In addition, the Observatory offers data on the framework conditions that shape regional competitiveness.
competitiveness. It further links the management literature to the innovation concepts to create a new tool, the cluster facilitator, which is in fact already in use in some clusters, but has not been systematically analyzed or measured. Once the facilitator is implemented, he/she or the organization is able to identify strength and weaknesses of the cluster and tie together the key stakeholders by a cluster vision and mission in the field. This work can also be beneficial in order to compare the cluster to the global market and make linkages to other clusters. These actions and the information gathered are not only crucial for government spending, but also for enhancing the absorptive and collaborative capacity of the overall cluster.

2.2.1. Collaborative and absorptive cluster capabilities

The collaborative and absorptive capacity frameworks enable the identification of separate elements that enhance networking within and beyond the cluster. Lai (2011) defines collaborative capacity as elements of purpose, structure, resources and communication in network relationships (see Figure 3). He even hypothesizes that without collaborative capacity in place, managing networks among multiple stakeholders is unlikely to succeed. He lays out these elements for an individual firm, but they can easily be applied to the overall cluster or network. Organization purpose is defined as having a leadership structure and a shared vision that focuses on collaborative efforts. This is similar to Provan and Kenis’ (2007) network goal consensus, which states that network members must be responsive to the goal of both, their employing organization and their network. An informal structure within an organization or network ‘allows flexibility and adaptability for collaborators to remain open in the midst of major changes, such as changes of major goals or members’ (Lai 2011, 451). Further, communication in general and communication channels in particular ensure information transmission and also put information in the context of solution-seeking. The last element of the collaborative capacity framework is the resource category. It includes intellectual, human and financial capital necessary to develop and sustain collaborative efforts – predominantly knowledge, skills and financial resources (see Table 2). This relates to the cohesion idea by Agranoff and McGuire (2001) in the sense that mutual dependency, particularly oriented to the availability of resources, is another explanation of cohesion. The inter-organizational literature suggests that actors in a network are in
some form of interactive dependency, usually based on resource exchanges (Pennings 1981). Thereby, ‘most organizations in a network are thus strategically interdependent, but some are more resources dependent than others’ (Agranoff & McGuire 2001, 313). These aspects of building collaborative capacity all aim to enhance networking and ultimately make a network or cluster more successful.

The paradox that arises from this set-up is the effort to collaborate while at the same time competing against each other. A closer look at the competition in high-tech clusters however reveals that there is a distinction between price and non-price competition. The non-price competition revolves around the contribution of corporate research and the capacity to catch-up through imitating the achievements of a leader rather than fiercely battling for the lowest price (Cantwell 2005). This implies that leading firms play a crucial in this type of set-up. Hence, the competitive advantage of a firm derives from ‘the cumulative and incremental learning experience of its management team’ (Cantwell 2005, 560). This shows that competition in clusters is more about benchmarking performance to assess the capabilities of learning and innovation rather than the mutual potential for damaging each other. Some even point out that the competitive race between stakeholders stimulates collaboration and innovation. Lundvall and Christensen (2003) find that firms experiencing strong competition were more frequently involved in product innovation and organizational change. And the intensified competition was the trigger to make such changes. Overall, ‘at the firm level, business-to-business (B2B) cooperation and competition are a key factor for the creation and successful development of a cluster’ (Hira, Giest & Howlett 2013). However, Lundvall and Christensen (2003) formulate the following caveat regarding fuelling such competition: it is necessary to promote organizational flexibility and innovative capability first, before competition policy can be implemented. In other words, the capacity to collaborate has to be established first, before competition can bare fruits in a cluster set-up.
Figure 2 Framework of collaborative capacity (Lai 2011, 449).

<table>
<thead>
<tr>
<th>Collaborative Capacity Framework</th>
<th>Basic elements</th>
<th>Collaborative activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Leadership</td>
<td>Identification of leadership role</td>
</tr>
<tr>
<td></td>
<td>Shared Vision</td>
<td>Mission statement/agreement</td>
</tr>
<tr>
<td></td>
<td>Network membership</td>
<td>Connection to a broader functional network</td>
</tr>
<tr>
<td>Structure</td>
<td>Formal and Informal Procedures</td>
<td>Memorandum/interagency planning document</td>
</tr>
<tr>
<td></td>
<td>Clear Roles</td>
<td>Agreed and informed policy guidelines</td>
</tr>
<tr>
<td>Communication</td>
<td>Information Links</td>
<td>Formal agreements/ personal connections</td>
</tr>
<tr>
<td></td>
<td>Active Communication</td>
<td>Communication technology, e.g. boundary-free information platform</td>
</tr>
</tbody>
</table>
Absorptive capacity, compared to collaborative capacity, focuses on the ability of a firm, a cluster or country ‘to integrate the existing and exploitable resources – technological opportunities – into the production chain, and the foresight to anticipate potential and relevant technological trajectories’ (Narula 2004, 6). The original concept is based on firms that already have a certain knowledge base and therefore are able to find and absorb or learn certain information available which is then used for technological development (Cohen & Levinthal 1990). Based on this, Giuliani (2005) focuses on a broader concept specifically for clusters, which entails two interrelated aspects: (a) the formation of linkages with extra-cluster sources of knowledge (i.e. the extra-cluster knowledge base), and (b) the structural characteristics of the intra-cluster knowledge system (Bell & Albu 1999; Giuliani 2005, see Figure 4). The two dimensions of intra- and extra-cluster are closely related in the sense that extra-cluster knowledge needs to be transferred to intra-cluster firms by an entity with outside linkages that also has the knowledge base to pick and distribute information. The intra-cluster knowledge system consists of the learning and collaboration processes between stakeholders, as shown in Table 3).

Absorptive capacity is also cumulative. This means that investing into and fostering capacity elements will pay-off later on. The mechanism behind this is that the more an organization or network connects to other stakeholders and the more knowledge is gained, the better everyone can identify missing information and who can offer it. Overall, this process encompasses three components: Exploratory learning, transformative learning and exploitative learning. All three elements are part of one process, as exploratory learning describes the confrontation with new knowledge,
transformative learning changes the way in which this knowledge is assimilated and combined with prior knowledge, while explorative learning describes how new knowledge is translated into action, which will ideally benefit the organization or network (Buenstorf and Murmann 2005; Lane et al. 2006; Harvey et al. 2010). With a wider knowledge basis, the expectation is that the network is prepared for changes and has better foresight.

However, Hughes et al. (2014) point out that the relationship between social capital, learning and performance is not as straightforward as it is portrayed in some research. They see absorptive capacity as positively moderating the relationship between network-based learning and response performance. Their study, based on individual companies, finds that there is a breakdown in transforming network-based learning into performance, which can be explained by the absorptive capacity levels. Hughes et al. (2014) summarize that ‘advantage accrues to entrepreneurial firms that are able to put meaning to the vast knowledge that social capital unlocks and those that effectively absorb and assimilate this knowledge into the firm’s activities’ (Ibid, 17). The same is true for clusters overall. As clusters gain the ability to pick and choose the knowledge that is needed, absorptive capacity levels are advanced and performance levels are more likely to rise. The facilitator can support this by focusing on the absorptive capacity elements within the cluster (see Table 3).
Table 3 Absorptive Capacity Framework (based on Giuliani 2005).

Both, the collaborative and the absorptive capacity framework allow for the identification of activities that enhance growth and productivity within a cluster. As Tables 2 and 3 show, the concepts are able to break down the capabilities into observable units, such as agreements, policy guidelines, virtual platforms, etc. Hence, they are fitting to make the work of a facilitator visible by defining those activities. They also make the connection to overall growth, as – even through such a relationship is a complex one to test – 'various studies support the view that one or more of the mentioned dimensions of the absorptive [or collaborative] capacity of a cluster are
related to its growth trajectory’ (Giuliani 2005, 281). Those studies include for example Giuliani (2003) or Mytelka and Farinelli (2003).

**Endogenous and exogenous dynamics**

The collaborative and absorptive capacity concepts can also be framed in terms of endogenous and exogenous dynamics, whereas internal collaboration is closely related to what is described as endogenous processes and absorptive capacities resemble contributions from external linkages. The traditional literature firmly supports the sole importance of endogenous development processes (Becattini and Rullani 1996; Paniccia 2002), focusing on the internal structure and dynamics of innovation (Krugman 1995), however more recent publications also emphasize the external linkages (Gallaud & Torre 2005; Belussi & Sammarra 2010). Exogenous elements include the access to external knowledge through for example, foreign direct investment (FDI), R&D long-distance collaborations, outsourcing and offshoring as well as relocating activities. This knowledge circulation created by those linkages prevents the cluster from cognitive ‘lock-in’ and ‘over-embeddedness’, which may ultimately become obstacles to local learning and innovation (Belussi & Sammarra 2010). The external knowledge gain can either be seen as something relatively passive or as something that is pursued actively – by a cluster facilitator for example. Thus outside investments could be categorized as a passive knowledge gain, while the enforcement of long-distance R&D collaborations falls on the active side of knowledge acquisition. Often the extent to which outside linkages are possible also has to do with the geography of a cluster. Being in a coastal area with no bigger cities in close proximity differs from a network set-up in a European environment where critical mass can be found throughout. Thereby, endogenous and external knowledge gains are not independent. They nurture each other through self-reinforcing processes (Sammarra and Belussi 2006). This means that without a well working internal knowledge exchange system, external knowledge does not bring as much value, because the possible knowledge gaps have not been identified. The opposite is also true, if endogenous processes are well managed and external linkages are actively pursued based on the gaps found within the network, the network is likely to succeed.
Based on this, supporting exogenous knowledge gains in relation to the existing knowledge base, requires an understanding of:

1) the cross-scale relationships, interconnections, and networks among formal institutions and organizations that provide context for social processes of renewal and transformation; (2) existing and evolving power relationships among different groups with scale-specific (a community-based organization) or multi-scale responsibilities (a government agency); (3) the informal and often more intangible, socio-political relationships of trust and influence that shape collaboration and learning; (4) control over knowledge and the valuation of different types of knowledge by different social actors, and (5) the degree to which evolving cultural norms and values remain consistent with collective action and collaborative learning. (Armitage 2007, 71)

The understanding of these factors should thus be part of the skill set of the cluster facilitator, as they enhance network capacity and knowledge circulation endogenously and exogenously.

The management literature offers further insights into network leadership, its connection to performance and gives pointers for the set-up and implementation of a cluster facilitator that is in charge of enhancing the elements of collaborative and absorptive capacity.

2.3. Network management and performance

Network management theory is divided between two opposing views of self-regulation and active management. One major theoretical approach is the population ecology view of organizations (Kaufman 1991), which argues that management does not matter and that organizations succeed or fail because they are lucky. By ‘lucky’, population theorists mean that some organizations have favourable environments with ample resources and are assigned to tasks that are tractable. What might appear to be good management, therefore, is an artefact of an organization's niche. Other analysts, for instance those who employ public choice (McLean 1987; Van Winden 1988) as a theoretical lens, might even see public managers as impediments (‘rent seekers’) – or at best, inefficient contributors (O’Toole & Meier 2011). In contrast, the introduction of programs, policies and reforms, as well as the resulting implementation of innovative
practices, processes and techniques have been branded by the term New Public Management (NPM) (Doig & Hargrove 1987; Hood 1995, 1998). The agenda of NPM embraces reforms aimed at improving the quality of public services, reducing public expenditure, increasing the efficiency of governmental operations, and making policy implementation more effective (Hughes 2003; Pollitt & Bouckeart 2000; Barretta & Busco 2011). Thus, NPM argues that management is the key to effective public programs and that, if governments were to adopt NPM’s set of favoured reforms (mostly borrowed from the private sector); citizens would get better government at a lower cost. ‘The overly strong versions of this argument can be considered ‘managerialism’: public management as the potential magic cure that converts failure into success’ (O’Toole & Meier 2011, xii). This description applies to clusters that were solely created by government initiatives with few preconditions for regional agglomeration.

Between these two extremes of uselessness and the power of management, the evidence-based public management view of this research aims to identify management techniques that work in practice. Much like similar movements in medicine (Guyatt et al. 1992) and in public policy (Heinrich 2007), this management perspective has as an objective to assess the conventional wisdoms (‘proverbs’, Simon 1946). This management concept thereby tries to move beyond the discussion of whether management works or not by analyzing building blocks for a systematic analysis of the relationship between management and performance. One aspect that seems to resonate in different studies is the fact that management is not a simple function, but, rather, encompasses several aspects. Further, the relationship between management and performance is nonlinear with respect to certain influences and should be considered in terms of interactions. O’Toole and Meier (2011) show in their book on public management – supported by several scholars – that:

- networking patterns of managers exhibit some similarities even when one compares data across national settings;
- networking by managers is not a product of pressure from outside the organization but, rather, reflects choices and actions by the managers themselves;
- the networking behaviour of managers contributes positively to performance;
• manager’s networking behaviour interacts with some resources and constraints in the environment to boost the effects of networking in nonlinear ways.

In order to boost performance, management encompasses different tools. One of the key questions for the relationship between management and performance is which and what extent instruments can be used both to influence goal-oriented processes and to create the conditions which facilitate the mutual formulation of targets. To determine those instruments, the characteristics of the network serve as the basic building blocks (De Bruijn & Ten Heuvelhof 1997).

2.3.1. Management tools

De Bruijn and Ten Heuvelhof (1997) define so-called ‘second generation instruments’ for the horizontal management of networks. They point out that within a network traditional governance instruments are often not very effective:

Instruments suitable for use in a network context are the so-called second generation governance instruments, such as covenants, contracts, communicative planning, parameters and incentives. These instruments are suitable for dealing with the pluriformity, self-referentiality, interdependency and dynamics of networks. They comply with what is termed the condition of contingency, that is, instruments need to fit into the structure within which they have to function. (De Bruijn and Ten Heuvelhof 1997, 123)

Important aspects for the use of second-generation tools include that actors who govern and function as managers deploy instruments in a way which differs from the traditional approach (De Bruijn & Ten Heuvelhof 1997). Further, there is a more indirect use of such tools, as well as fine tuning and multilateralism. Fine tuning encompasses the idea of tailoring specific tools to the differences between actors and to their specific sensitivities. Also, multilateralism has succeeded unilateral directives in this approach. The general nature of collaboration is reaching an agreement on the nature and direction of the governance interventions (De Bruijn & Ten Heuvelhof 1997).

De Bruijn and Ten Heuvelhof (1997) add two further points to the analysis of network management. First, they identify a current trend of placing ‘governance’ at a distance from ‘government’, the so-called ‘adding actors to the network’ form of
management. This emphasizes an important element of identifying and implementing a cluster facilitator, because the distance to actual government agencies gives the new actor more flexibility and room for negotiation, while the public coordination adds stability and persistence (Kickert et al. 1997). This is crucial for the dynamic of an ever-changing cluster. Adding to this point, De Bruijn and Ten Heuvelhof (1997) also state that network management in general and adding an actor specifically will change the network and thus lead to new problems and opportunities which are hard to predict owing to their complexity and interrelated nature. They even compare these reorganizing processes to ‘garbage cans’: highly contextual combinations of people, choice opportunities, problems and solutions (March & Olsen 1989, 80). In sum, the key statement regarding network management and according instruments is that ‘instruments enable network management to take place’ (De Bruijn & Ten Heuvelhof 1997, 136), but are a long way from being clearly defined.

### 2.3.2. Facilitator leadership

The leadership function of the facilitator focuses on the informational, referent and expert powers as well as the legitimacy given through the close relationship to government, instead of being characterized by reward, coercive or ecological powers (Svetina et al. 2004). In this role, the facilitator can take the form of an individual, a local association or knowledge institution (Gagne et al. 2010; Mesquita 2007). Accounts of cluster facilitators in the literature are dominated by a focus on individuals, who are called cluster or network brokers (Visser & Atzema 2007), managers, promoters, leaders or trust facilitators (Mesquita 2007). Institutions and other organizational entities are also capable of being facilitators for cluster dynamics when they are identified as such. Thus, a facilitator may be mandated or contracted by government, but does not embody or enforce any hierarchical elements (Provan & Kenis 2007). In most cases the facilitator is publicly appointed by government and/or main industry stakeholders and established throughout the development of the cluster. For individual facilitators, industry and government pick managers that are well-known in the field and are able to create new opportunities for the cluster through their network and knowledge. Usually they have the official title of a cluster facilitator or cluster manager. In terms of organizational facilitation, one entity naturally emerges as the core node of the network by organizing
and bringing together the cluster. In this case, the title might not be ‘facilitator’, but the cluster activities all point towards its main coordinator.

Overall, the implementation of a facilitator is similar to the establishment of clientele units or administrative units, which flourished in the 1970s. ‘Human rights units dealing with minorities and the disabled are good examples of network mobilization and activation occasioned by government organizational (re)engineering’ (Howlett 2011, 75). This activity can also be termed as a form of ‘network administration organization’ (NAO) (Provan & Kenis 2007). The basic idea is that a separate administrative entity is set up specifically to govern network and its activities. The network broker or facilitator plays a key role in coordinating and sustaining the network – and unlike the lead organization model, the broker is not another member providing its own services. Thereby, NAO may be modest in scale, consisting of only a single individual, the facilitator or broker, or it may be a formal organization, consisting of an executive director, staff, and board operating out of a physically distinct office (McEvily & Zaheer 2004; Provan et al. 2004).

Similar to the idea of brokering, ‘network orchestration’ analyzes the leadership function of a hub firm in networks (Dhanaraj & Parkhe 2006). This literature emphasizes the connections between stakeholders and the knowledge exchange happening within the network. It further supports the argument that innovation networks need a hub with a dedicated management resources and representation of key stakeholders (Leven, Holmstroem & Mathiassen 2013). The hub firm can access the knowledge ‘residing at different points in the network and can arrange its transfer to other points in the networks where it is needed’ (Dhanaraj & Parkhe 2006, 660). Further, this central node in the network creates an ‘appropriability regime’, which includes governing the ability of a company or entrepreneur to profit from its innovation (Teece 2000; Dhanaraj & Parkhe 2006). And finally, the hub firm also contributes to network stability. The understanding of a hub firm orchestrating the network targets similar collaboration and performance goals as the cluster facilitator framework, however, facilitation in this study is connected to an independent or government-financed institution rather than a company. This has the advantage that facilitation is less focused on profit-making, but rather about the networking structures, the collaborative and absorptive capacity and the link to government.
Activities that describe facilitator leadership in a network are ‘closure and brokerage’, which focus on the flow of information (Burt 2000).

Both mechanisms begin with the assumption that communication takes time, so prior relationships affect who knows what early. Information can be expected to spread across the people in the market, but it will circulate within groups before it circulates between groups. (Burt 2000, 351)

Thereby, closure affects the access to information as well as makes it less risky for people in the network to trust one another. Brokerage, on the other hand, connects holes – so called ‘structural holes’ – in the system. People on either side of a structural hole circulate different information. Those holes are thus an opportunity to broker the flow of information between people, and control the projects that bring together people from opposite sides of the hole (Burt 2000, 353). This brings several advantages to the role of a broker, which also applies to cluster management tasks:

- Control advantage
- Early learner
- Volume of information
- Attractive to be added to a network

These elements translate into the advantages a broker should have within a cluster – bringing together otherwise (more) disconnected people and learning earlier about the activities in different groups. Also, he or she has a higher volume of information through possessing a larger amount of connections and is more likely to be added to a network. Burt (2000) describes these advantages as beneficiary for the whole network – emphasizing the entrepreneur as ‘a person who adds value by brokering connection between others’ (Ibid, 354). For clusters, it is the formation of a bigger network that ultimately benefits the actors within it through the broker. This describes the first step in cluster building: closing structural holes and building relationships that enable long-lasting information exchange.

Another strand of literature that the cluster facilitator model can built on, is that of boundary spanners (Leifer and Delbecq 1976; Doz and Hamel 1998; Williams 2002, 2010). Boundary spanners are actors that operate and encourage collaborative environments (Williams 2010). One of the dominant themes in this literature is that of a
Reticulist scholars focus on an individual that has certain traits that help to bridge interests, professions and organizations (Webb 1991; Williams 2010). The challenges described are also similar to those of cluster facilitators with acknowledging the mixed modes of management – networks, hierarchy and market (Williams 2010). However, while the scholars in boundary spanning and reticulists mainly take on an individualistic perspective with a focus on the personal level of interaction, the manager in the cluster setting can also be an institution in which several individuals work to connect members.

Thereby, the cluster facilitator is different from an anchor firm or star scientist. Anchor firms are those companies that are well connected to customers and suppliers as well as to outside sources. More precisely, they attract new productive investments by external forms, both at vertical and horizontal levels (i.e. suppliers, key customers, complementors and/or rival firms). Anchor firms also ‘orchestrate cluster knowledge flows by strengthening their local network and providing a vision for uniting innovation, and promote new firms formation by fueling technological opportunities local start-ups may exploit’ (Baglieri, Cinici & Mangematin 2012, 245). They follow their own interest and are seeking profitable outcomes. Anchor firms are also not dedicated to a specific cluster if they do not see personal gains, hence they could not substitute a cluster manager that is neutral and has all stakeholders’ interests in mind.

Star scientists, on the other hand, are not only ‘carriers’ of knowledge (Glaeser 2004; Florida 2002, 2005), but also attract the attention of other academic scholars, policy and venture capitalists (Maier, Kurka & Tripl 2007). Some findings show that the stars themselves, rather than their potential discoveries, play a crucial role in the formation and transformation of high-tech industries, emphasizing their embodied knowledge, insight and energy (Zucker & Darby 2006; Maier, Kurka & Tripl 2007). However, the findings also point out that star scientists tend to move to clusters where other renowned scientists are housed, this means there are a few places that are

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6 Based on a real estate concept, Agrawal and Cockburn (2003) define an anchor tenant as a large, locally present firm that is: (1) heavily engaged in R&D in general and (2) has at least minor absorptive capacity in a particular technological area (Niosi & Zhegu 2010).
‘magnets’ while other clusters have to compete for these experts (Williams et al. 2004; Maier, Kurka & Trippl 2007). Again, they are not committed to one cluster, but rather clusters compete for the attention of star scientists. In contrast, cluster facilitators would be the ones advertising the cluster to this group of scientists.

Management by facilitators

Overall, facilitators aim to create ‘interagency collaborative capacity’ (Agranoff & McGuire 2001). Thus, the management of clusters further includes elements of competitiveness and network support. There are different concepts that define capacity: Agranoff and McGuire (2001) emphasize that leaders have to create an environment in which stakeholders move ‘toward tangible resources exchanges plus cooperative dispositions and mutual understanding’ (Ibid, 307). Common network management sequences they summarize based on North American public management research, are activation, framing, mobilizing and synthesizing.

First, activating the right players is crucial to the task of governing clusters. According to Scharpf (1978), selective activation of potential participants in the network is ‘an essential prerequisite of successful inter-organizational policy formation and policy implementation’ and, if performed correctly, is based on the ‘correct identification of necessary participants in policy-congruent networks’ (Ibid, 364), as well as the willingness of these potential participants to devote resources to the network (Agranoff & McGuire 2001). In a cluster setting those participants include different stakeholders from industry, university and government. Complementary, the conduction of ‘deactivation’ – which is also part of the facilitator repertoire – rearranges and shifts network structures if they are not performing as desired (O’Toole 1988; Klijn 1996; Klijn and Teisman 1997; Temeer and Koppenjan 1997). Second, framing involves establishing and influencing the operating rules of the network (Gray 1989; Mandell 1990; Klijn 1996), influencing its prevailing values and norms (Kickert & Koppenjan 1997; O’Toole 1997) and altering the perceptions of the network participants (Temeer & Koppenjan 1997). As a third element of management, Agranoff and McGuire identify mobilization of stakeholders. Mobilizing ‘requires a view of the strategic whole and an ability to develop and achieve a set of common objectives based on this whole’ (Mandell 1988, 33). Facilitators support the cluster by mobilizing participation and forging agreements among those participants
The fourth and last element of network management addresses synthesizing the cluster by creating the environment and enhancing the conditions for favourable, productive interaction among network participants. This includes negotiations between stakeholders and between facilitator and stakeholders as well as finding common ground and synthesizing different strategies (Klijn & Teisman 1997; Agranoff & McGuire 2001). Activating, framing, mobilizing and synthesizing can be summarized as ‘designing’ the strategy of a cluster (Doz & Hamel 1998, 141). Overall, important management behaviours include facilitating and furthering interaction among participants (Kickert & Koppenjan 1997); reducing complexity and uncertainty by promoting information exchange (Innes & Booher 1999; O'Toole 1988 and 1997; Mossberger & Hale 1999); changing incentives to cooperation (Kickert et al. 1997); developing new rules and procedures of interaction (Klijn 1996; Termeer and Koppenjan 1997); changing positions, relations and roles of participants (Klijn 1996; Kickert et al. 1997); helping the network to be self-organizing (Innes & Booher 1999); and engendering effective communication among participants (Mandell 1990; Kickert et al. 1997). (Agranoff & McGuire 2001, 364)

Bryson, Crosby and Stone (2006) define similar tasks for creating successful collaboration. They also point out that a collaborative formation needs a ‘linking mechanism’ (Waddock 1986), such as a brokering organization or a legitimate convener that can facilitate collaboration formation (Waddock 1986; Gray 1989). The elements of successful networking include: building leadership, legitimacy and trust, manage conflicts and steer planning processes, as well as structure and govern the network (Bryson et al. 2006). Provan and Kenis (2007) add that successful governance is based on forming key structural and relational contingencies: trust, size (number of participants), goal consensus and the nature of the task. Some of these are given in a cluster setting, such as size and others can be targeted by a facilitator and enhanced over time. They also emphasize that the leadership structure or rather the one lead organization lowers the level of the need for network level competencies, which again raises the chances of success and higher competitiveness of the cluster.

Legitimacy and trust are especially important when it comes to creating collaborative dynamics that enhance competitiveness. This is consistent with the argument that economists are making in relation to the so-called ‘stag hunt’. This game-
theoretic approach to collaboration in a competitive environment indicates that the viability of cooperation depends on mutual beliefs and rests on trust (Skyrms 2003). It ties trust attitudes to specific behavioral patterns that are candidates for generating macro-level outcomes (Bosworth 2013). In sum, the stag hunt perspective supports the importance of trust in a facilitator-stakeholder relationship by making an economic argument for trust causing prosperity as a change in attitude leads individuals to make different decisions in settings where their decisions have economic consequences (Bosworth 2013). Thereby,

social capital strengthens networks that create initial matches, fosters continued success (promotion, reduced turnover), supports research and development and generally encourages positive spillovers. The observed and plausible causal link between generalized trust attitudes and economic prosperity, the need for individuals to trust their partners will take complementary actions in order to coordinate on efficient equilibria in Stag Hunt games, and the relevance of coordination to growth and productivity...(Bosworth 2013, 13)

Applying these findings to stakeholders in the cluster, the study concludes that the establishment of trust is an central element to overcoming free-riding and coordination problems in a network. Overall, the stag hunt perspective does not solve the problem of cooperation, it however allows for cooperation in equilibrium (Skyrms 2003). The facilitator creates trust and legitimacy by being appointed or working closely with government and also knowing and being known in the industry and research community of a specific field. These pre-conditions lead to acceptance and participation by industry and research players. This is another reason for an independent facilitator, as opposed to a leading firm, since knowing that the facilitator works for the benefit of the whole cluster instead of his or her own profit, creates more trusting relationships. Another aspect of having this basis of legitimacy and trust is that facilitators mostly do not work in a ‘shadow of hierarchy’ and need stakeholders to work with them voluntarily rather than forced (Sydow et al. 2011).

2.4. Factors contributing to network success and failure

Trust and legitimacy are integral parts of cluster success and in turn, if these components are missing, it leads to possible failure. Trust, mutuality and common
identity define the problem orientation and commitment of members and appear to be critical if networks are to perform a coordinating function (Parker 2007). Collaboration partners build trust by sharing information and knowledge demonstrating competency, good intentions, as well as follow through (Merrill-Sands & Sheridan 1996; Arino & de la Torre, 1998; Folke et al. 2005). Improving communication among network members and common goals also helps to foster trust-building practices. Once trust is established, the risks of networking, such as free-rider problems or the ‘weakness of loose ties’ (Orton & Weick 1990), which are caused by a missing hierarchical governance mode, can be compensated by professional or community-level coordination (Urbaniec & Gerstlberger 2011). Building trust and the growth of networks is also closely related to investments in social capital.

Several authors have regarded social capital as the ‘glue for adaptive capacity and collaboration’ (Folke et al. 2005, 111). Social capital refers to ‘features of social organization, such as networks, norms, trust, which facilitate coordination and cooperation for mutual benefit’ (Putnam 1993, 67). But the emergence of this trust and capital is not automatic. Studies have shown, for example, that less favoured regions (LFRs) have low levels of social capital, preventing them from seeking joint solutions or develop institutional capacity to face current problems (Doeringer & Teckla 1990; OECD 1993). LFRs are those areas which lack the factors for an innovation system, such as critical mass of innovative firms and institutions, and a significant range of interactions among the different actors involved in the innovation process. And while social capital creates the potential for fruitful discussions to take place, the trust in actions or ‘intellectual capital’ provides a common basis for problem definition and agreements. Intellectual capital can be defined as the relationships, innovation efforts, infrastructure, knowledge and skill of network members – basically any intangible resource that can generate value in the future without having a physical or financial form (Sullivan 1999; Lev 2001; Hormiga et al. 2011). In other words, intellectual capital combines human, structural and relational capital, which define the available knowledge through network members, the strategic vision for a network and the set-up for knowledge exchange. On top of that, according to Innes et al. (1994), there is a third type of capital that helps to connect stakeholders: political capital. ‘In form of alliances and agreements or proposals that provide mutual gain creat[ing] the possibility that proposals will be adopted’ (Ibid, ix).
This implies that consensus-building has a positive effect throughout the whole policy cycle. It is obvious that if larger networks have agreed upon what the problem is and how it is defined, seeking a solution becomes easier and faster in the formulation and decision-making phase. Also, once an agreement has been reached on a solution, several network managers act as channels for implementing and speeding up the process. They also make it easier to monitor results in the evaluation phase as they frame the realization of the policy on the ground (Howlett, Ramesh & Perl 2009). This is supported by research which suggests that the readiness to accept new ideas largely depends on the stability of existing dominant coalitions of actors (Benz & Fuerst 2002).

Further, the incentive to participate in solution-finding and knowledge-sharing becomes even stronger in some cases after a critical mass of committed and important players forms along with some first-stage agreements (Innes et al. 1994). However, stakeholders need common ground to collaborate. This happens in cases when a severe problem is present or when – specifically firms – see an advantage in building ties with different groups to acquire necessary resources for growth or knowledge development (Provan & Kenis 2007). ‘Firms strategically adapt and align their networks to gain the resources they need to ensure successful emergence and early growth’ (Hite & Hesterly 2001, 278). This results in uncoordinated efforts by those who have a stake in the success of the network, however it does not guarantee a long-term network or reaching common goals. Due to possible collective action problems, the introduction of a network leader helps to coordinate those sometimes ad-hoc efforts. The basic idea is that a separate administrative entity is set-up specifically to govern the network and its activities. The identification of common objectives by a network manager enables the network to be more consistent across levels and increases cooperation, as goals become more transparent, relatable and reliable (OECD 2001). A manager creates a sense of purpose and legitimacy.

As Human & Provan (2000) point out:

Legitimacy refers to the status and credibility of the network and network activities as perceived both by member firms and outside constituents like funders and customers. It is the acceptance of the network by these internal and external groups, resulting in cognitive support and commitment as well as resources, that will ultimately determine whether the network is able to survive as a viable interorganizational form. (Ibid, 328-329)
It is the role of the network manager to create different elements of this legitimacy, which includes to set-up a new physical entity that represents, in a very concrete way, the network itself (network as an entity), and its possibilities (network as form). In doing this, the manager builds his or her own legitimacy (network as entity) at the same time. These elements must be carried based on support from members of the network (inside-out legitimacy) and external stakeholders like funders or customers (outside-in legitimacy). Both are crucial for the sustainability of the network. As Human and Provan (2000) show, when the legitimacy of the manager deteriorates due to a lack of inside-out or outside-in legitimacy, network failure becomes more likely. What happens is that when the network manager dissolves (network as entity), ‘many members no longer believe in the network concept (network as form) and business exchanges among former members become fewer and weaker than before (network as interaction)’ (Human & Provan 2000, 358). Thus, network building must include a broad legitimacy-building strategy that addresses internal and external stakeholders.

On top of incorporating key stakeholders and their relationships, the manager must take into account different aspects and obstacles of maintaining a network. First, although members of the network maybe representatives of their organizations, groups or firms, this does not mean that the whole organization supports networking efforts. In some cases, this can be attributed to the fact that there is tension between competitive and cooperative dynamics as ‘achieving both goal congruence and partner cooperation is often complicated by the reality that those who collaborate in one network must also compete vigorously against each other for contracts and funds elsewhere’ (Goldsmith & Eggers 2004, 46). This means, the more specialized a network is in one field or industry, the higher is the likelihood of opposite relationship dynamics in another network set-up. In other words, the density of one network is not transferrable to another collaboration. Thus, as Mandell & Keast (2008) emphasize, members must ‘continually work to bridge the gap between what is agreed on within the network and making sure these agreements will be supported by their respective organizations and/ or constituency groups’ (Ibid, 721; Porter 1981).

Second, network density enhances resilience and adaptive capacity, but only to a certain point. As Bodin (2006) found, density reduces vulnerability and facilitates the exchange process, however high levels of density might in fact ‘contribute to a
homogenization of the system [...] which would reduce the system’s ability to cope with changes, disturbances and surprises’ (Bodin 2006, 26). Ultimately, this can lead to what Schrank & Whitford (2011) define as network ‘involution’, where there are institutional safeguards against opportunism, but where exchange partners for one reason or another have become too dependent on each other and following from that, fail to absorb information from outside the network. A mechanism to prevent involution is to include elements surrounding the network. Networks do not operate in isolation and while there is a need to understand what is going on inside the network, it is as important to incorporate the social, economic and political realities that are part of the external environment surrounding the network (Mandell & Keast 2008). This is especially true in policy areas where the EU or even global policy players affect the network dynamics.

Further, if the network manager is unable to neither mitigate opportunism nor facilitate relationships, ‘network production is all but impossible and stillbirth or devolution – that is absolute network failure – occurs’ (Schrank & Whitford 2011, 170). Absolute network failure defines the break-up of existing relationships (network devolution) and the nonappearance of potentially profitable or productive networks (network stillbirth). Other forms include the possibility of relative network failure, describing the lack of competencies (involuted networks) or the opportunism of network members (contested network). In sum, the manager plays a key role in coordinating and sustaining the network as well as creating trust, mutuality and a common identity (Provan & Kenis 2007).

Overall, we see that for the establishment of a dense and breadth network, there need to be high levels of interconnectedness between all relevant stakeholders horizontally, including other members of the field, and vertically, which describes the national, European or even global (policy) dimension. The analysis further shows that the formation of such a network is almost impossible without some kind of leadership. As outlined above, there are sometimes competing members of the network and often organizations pursue egoistic goals. Thus, a network can only be successful if it addresses (1) the bargaining dilemma or prisoner’s dilemma, which describes situations in which defection from cooperation is more rewarding than compliance and (2) solves the structural dilemma, which describes the inter-organizational structure of horizontal
coordination (Boerzel 1998; Scharpf 1997). Thereby, network governance is a viable option if it is able to inhibit legitimacy and create social capital among stakeholders.

2.5. Policy challenges posed by high-tech industries

This study specifically looks at high-tech industries, as clusters both predominantly occur in these fields and policy also uses cluster policy mostly for facilitating high-tech development. Research in high-tech industries is moving at a fast pace and as these technologies mature, they change industry structures and supply- and demand-conditions. After a so-called fifth generation of innovation, which was defined by a process of gradual opening up and an increase in the role of collaboration, alliances and partnerships, stakeholders are entering the sixth phase of innovation. This marks the beginning of the inclusion of emerging economies, and thus widens the scope and scale of globalization. To a large degree, the collaborative efforts and networking capabilities now determine the success of a region or even country (Mroczkowski 2012).

High-tech industries are not only challenging due to their rapid speed in development, they are also often described from a nested system perspective, because the ‘technology is not only related to the sophistication of its individual components, but also to the complexity of its relational and functional integration’ (Bauer, Lang & Schneider 2012, 5). This means that policy has to accommodate heterogeneous components and subsystems in which synergies exist between industries and technology in the high-, medium- and low-tech sector. At the same time, this has to be met with a broad spectrum of policies, which go beyond a certain sector or government level. Further, policy initiatives have slowly extended to include non-governmental actors and civic institutions. This is especially true for situations in which implementation failed and the focus shifted towards the specific governmental and non-governmental actor constellation (Mayntz 1983). Further, the development of high-tech products is often related to uncertainty, risk and the challenge of drawing in new investment. Thereby, the communication and collaboration with industry players to resolve and tackle some of these hurdles often poses a challenge in itself for government officials. In this set-up, government could aim to take the role of a coordinating and regulating entity (Rhodes 1996) with the goal of crafting order and ‘thereby to mitigate conflict and realize mutual
gains’ (Williamson 2000). This however may an insurmountable obstacle for government and many policy strategies take a ‘learning by doing’ approach instead, as they develop the according initiatives (Bauer, Lang and Schneider 2012).

On a larger scale innovation policy can be situated on a continuum along creating favourable framework conditions to ‘picking winners’. Both have their advantages and disadvantages when it comes to influencing market developments. While creating the right framework conditions often makes countries or regions conducive to investment and relocation into the area through tax credits or basic funding schemes, it also often does not target the needs of the high-tech industry specifically. In contrast, ‘picking winners’ is a rather short-term approach, as choosing a certain sector or even company would most likely make them competitive on the market, however it does not create favourable conditions for networking or benefits on a larger scale. Cluster policy is somewhere in between the two, as it does pick a region or area the policy is focused on, however at the same time it is often connected to creating larger incentives that favour more players and enhance networking.

The underlying concept that captures the challenges on either side of the spectrum connected to high-tech industries is the idea of a knowledge or learning economy (Lundvall 2001). The OECD (1996) defines those as being based on the production, distribution and use of knowledge and information. This is reflected in the trend in OECD economies towards ‘growth in high-technology investments, high-technology industries, more highly-skilled and associated productivity gains’ (Ibid, 7). Knowledge economies target learning capabilities and absorbing information and tacit knowledge as well as building networks where knowledge exchange can occur. To align policy with the network-dominated fields in the knowledge economy, many scholars suggest to move towards network governance. For government, using networks as a tool helps to ‘ensure conformity with the overall objectives of government, [...] to receive the stake of some of its tasks and reach various target groups with fewer resources and less display of repressive control from above’ (Torfing 2005, 307). Thus, the overall goal is policy integration and coordination among various groups while reducing implementation resistance (Torfing 2005; Juhola & Westerhoff 2011).
The cases of this study target the biotechnology or life science industry within the larger field of high-technologies. Biotechnology poses some specific challenges connected to the dependence on knowledge creation and commercialization of research.

**Biotechnology**

Biotechnology encompasses different research subjects and is summarized as the ‘application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services’ (OECD 2005, 9). It is a prime example for an industry based on scientific knowledge. New knowledge is usually generated by dedicated biotech firms (DBF), which require high levels of innovative capacity. Stakeholders in the cluster that cannot absorb new knowledge from those DBFs are thus facing major disadvantages (Nilsson 2001). In turn DBFs are heavily dependent on the financial resources of bigger companies, because the production of, for example, a new medication requires large up-front costs and long development times. This mutual interdependency, which extends to government funding and qualified personnel through universities, explains the tendency for these actors to agglomerate close to each other (Zeller 2001; Cooke 2002a; Feldman & Francis 2004). Thus, the nature of biotechnology is that it needs well-educated and highly trained personnel, as well as capital from both the private and the public sector.

Biotechnology can further be termed a ‘transfer science’ that has a networking character (Dunkel 2004). Networks form a knowledge-intensive cluster in terms of firms and organizations, which are embedded in a specific region and characterized by localized interactive learning. Policy interventions in the field have the opportunity to ‘lend these systems a more planned character through the intentional strengthening of the region’s institutional infrastructure – for example, through a stronger, more developed role for regionally based R&D institutes, vocational training organizations, and other local organizations involved in firms’ innovation processes’ (Asheim & Gertler 2005).

Asheim and Gertler (2005) distinguish between synthetic and analytical knowledge. The latter type describes knowledge created based on formal models, codified science and rational processes. Biotechnology research falls into this category. In contrast, the creation of synthetic knowledge applies to industries, such as engineering and shipbuilding and usually involves the novel combination of existing knowledge.

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Further, learning is seen as a necessary component of the successful development of a biotech cluster, which is defined as an ‘interactive and socially embedded process’ (Lundvall 1992, 20). Thereby, the phenomenon of clusters and biotechnology go hand-in-hand, as biotech – as a science-intensive ‘sunrise’ industry – grew at the time when geographical clustering became more prominent. The type of links which support ties in biotechnology, can be distinguished as follows (6 et al. 2006, 200):

- Board-level links, include interlocks (overlapping board memberships for influential individuals), but also including less formal links;
- Professional-level links, including informal ties between scientists in the same sub-discipline, and a more formally sanctioned links in the course of collaboration in research and development;
- And other staff-level links, including between marketing staff, account managers, project managers for joint projects and strategic alliances.

Thus, informal and formal ties appear to be symbiotic in the biotechnology field. Government is in the position to create and support these ties. Typically, measures are taken to promote the appearance of technology-based firms through the creation of programs, subsidies, grants and fiscal benefits. These efforts pay off, as the growth of biotechnology in a number of countries can be traced back to dedicated initiatives. Mostly Western governments allocate financial support specifically to the so-called pre-seed stage of life science start-ups. Due to the horizontal character of biotechnology, many countries have also created cross-disciplinary government boards in support of science parks created for high-technology research (Coenen et al. 2004).

Overall, biotechnology represents many evolving technology fields, such as nanotechnology, that have informal and ill-structured information and tacit knowledge exchanges as key components for shaping the scope and type of network emerging. Ideally, stakeholders in the formed cluster possess excellent information about other actors in the field, their capabilities and strategies and about the leading edge of techniques and practices. In the absence of such information, key players need a central node, a facilitator, to make crucial developments available to them.
2.6. Summary and hypotheses

In sum,

'policymakers realize that, without public support, market forces alone will not suffice. At the same time they grapple with the complexity of the task, realizing the success can be elusive, progress can be slow, and failures are common’ (Mroczowski 2012, 205).

Thus, government needs specific tools to tackle the complexity of clusters. A cluster, even though it is a local agglomeration of firms, universities and government actors, is embedded and connected to different levels of government and framework conditions. Targeted regional initiatives, such as the support of technology transfer offices\(^8\), affect the clustering process, as does the overall funding of universities and the national-level goals for regional developments. Currently, there is a trend to emphasize global connections of clusters and the linkages beyond national boundaries, but national and regional policy input are very much involved in clustering (Wolfe & Gertler 2004; Wolfe 2008; Peck & Lloyd 2008). Thus in many countries and jurisdictions, the concept of multi-level governance and place-based policy has been adopted to help to achieve the desired degree of cross-jurisdictional coordination (Wolfe & Creutzberg 2003).

These linkages in the multi-level framework and within the cluster – horizontally and vertically – entail both helpful but also hindering dynamics for both sides, government and stakeholders. From a government point of view, the lack of a precise definition of what a cluster is and how to exactly support the process of clustering presents opportunities and drawbacks: On the one hand, the concept allows for a broader definition of the initiatives implemented in that region and on the other hand, this lack of precision can lead to confusion around the focus and goal of cluster policies (Peck & Lloyd 2008). On top of that, innovation in clusters often appears spontaneous and unpredictable, which makes it difficult to plan a systematic way of action. Adding to the problem of fuzziness of clustering itself and the overlap of government levels in

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\(^8\) A technology transfer offices or TTOs provide an interface between industry and the institution or university they are located at. They usually offer information on intellectual property rights and contractual relationships with industry. In many regions they are also involved in setting up support structures for researchers to gain funding or connect with industry.
tackling cluster issues, is the fact that government is lacking knowledge that is required to implement these policies efficiently (Sautet 2002; Wolfe 2008). Governments lack ‘the know-how, know-who and experiences of participants in the clusters they address’ (MacDonald 1992; Hospers, Desrochers & Sautet 2009, 291).

From a network perspective, stakeholders find it difficult to get their message across to policy-makers. This gap between cluster firm and institutions within the political system can lead to less effective policy frameworks and policy failing to provide relevant knowledge-bases for development (Borras & Tsagdis 2008). This ‘policy relevance gap’ between different levels of government and the cluster stakeholders shows that for successful clustering to happen, new channels of communication and intermediation are needed both horizontally among, for example government departments or cluster stakeholders and vertically across levels of policy-making and planning. Halkier (2011) calls this ‘a new multi-level paradigm in which promotion of indigenous growth and competitiveness is the shared goal and regional actors play a prominent role within a broad participatory framework’ (Ibid, 335).

The study argues that the establishment of a cluster facilitator, which is a core node in the cluster and at arm’s lengths of government, is a solution to the challenges posed by high-tech fields and their inherent innovation dynamics. As Borras and Tsagdis (2008) point out: ‘If cluster policies are to be strategic and able to tackle the actual and future problems faced by cluster firms, efforts need to be placed on creating forums and spaces where firms and policy makers can share, develop as well as revise their strategic views’ (Ibid, 263). The cluster manager poses such a space. More specifically,

Cluster management goes beyond management of an individual organisation. It implies mediating and facilitating the relationships of multiple cluster members. Each of the cluster members has their own agenda, and a key challenge for cluster managers is to make sure those agendas are united into common objectives and collective actions, that conflicting interests are resolved, and the relevant organisations see enough added value from their participation in cluster activities (Schretlen et al. 2011, 3).

Based on the introduction of the absorptive and collaborative capacity frameworks into the combination of management literature and the innovation systems approach, the following hypotheses emerge.
3. Research methodology

Operationalizing the hypothesized relationship between facilitators and cluster performance is done by looking at the intermediate causal variables of absorptive and collaborative capacity. The cluster facilitator is the enabler for those variables, which then affect or rather enhance the level of competitiveness. The facilitator as the critical success factor is a contextual and process-related performance indicator. As a result, facilitation is considered an enabler rather than direct indicator of cluster performance (PwC 2011). This means that the cluster facilitator cannot influence cluster performance directly by being present, but by carrying out activities that are defined under the concepts of absorptive and collaborative capacity (see Figure 4). For example, developing a mission statement, making links between stakeholder within and outside of the cluster or acquiring knowledge from extra-cluster sources.

To prove that there is a relationship between the existence of a facilitator or facilitator-type organization and cluster performance, a ‘mixed method’ approach was used. The survey part of the analysis describes the general relationship between the existence of a facilitator and cluster competitiveness. The questionnaire addresses facilitators, government actors and industry stakeholders in innovation-driven industries, including clusters with and without cluster management. The questions focus on the absorptive and collaborative capacity framework, asking for the existence of the individual elements suggested by theory. The custom design of the survey means that

Figure 4 Relationship between facilitator and overall performance.

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the stakeholders were specifically targeted based on the triple-helix structure and the
data gathered was tailored to the focus on cluster management (Arthurs et al. 2009).
Thus, the survey part aims to answer the research question: *Is cluster facilitation similarly applied and understood beyond the biotechnology industry and does it enhance capacity-building and ultimately performance?* In other words, *is the facilitator a generalizable tool for all clusters?*

The semi-structured interviews in specific clusters as the second part of the
analysis, contribute to the mechanism of the relationship between facilitator and
performance. The qualitative part of the research thus aims to answer the question, *how a cluster facilitator contributes to cluster performance.* Further, the goal was to understand in detail how the position of the facilitator is connected with the different stakeholders in the cluster and how his or her actions affect the network. The cases were selected out of the group of emerging, policy-driven clusters in innovation-driven economies with a variation of the independent variable, cluster management and include Medicon Valley (Denmark/ Sweden), Chicago (Illinois, US), Singapore and Vancouver (British Columbia, Canada).

This mixed-method approach highlights different aspects of the relationship between cluster management and cluster performance, as the survey defines the relationship by analysing the activities, duration and characteristics of a facilitator. The interviews determine the hypothesized mechanism that is responsible for the relationship (Hedström 2008). These methodological steps strengthen the study due to the fact that the strength of one approach can offset the weaknesses of another, which ultimately increases the generalizability of the findings (Neuman & Robson 2009, 349). The development from a relational to a causal relationship through survey and case analysis is able to confirm and broaden theory and lay the foundation for future research to move towards a generalizable rule, in which single cases become less important (Sekhon 2008).
3.1. Survey research

3.1.1. Theoretical context

Structural cluster components

Clusters around the world differ greatly in terms of geographic location, investment structure, underlying policies and the question of quality or quantity as well as national sales or export. But, underneath these differences, all clusters share a similar basic structure, which contains three groups: research institutions, government, and industry. This triple helix structure forms the basis for interactions within the cluster⁹.

Looking at the different clusters from a triple-helix perspective offers many advantages: First, it is a stable and therefore observable structure that defines separate analytical areas (Leydesdorff & Meyer 2006). Second, the university-industry-government relationship is not tied to the national level, but can be found locally or regionally – depending on the unit of analysis (Lundvall 1992). Third, a change in the institutional interface of the triple-helix can serve as an indicator for underlying dynamics and a change of expectation or dominant role within the cluster (Leydesdorff & Etzkowitz 1998). This especially helps to map the development of a cluster towards a fully grown triple helix in form of ‘equivalent and overlapping institutional spheres’ (Etzkowitz 2003, p.302), as ‘[i]nteractions at the network level generate mutual expectations that feed back on the institutional arrangement’ (Leydesdorff & Etzkowitz 1998). Based on this common structural element, the cluster population was identified for the survey.

Cluster excellence

The rationale behind focusing on clusters and cluster policies is based on the expectation that it leads to higher economic performance in the region (Porter 1990). For this relationship to work, various studies emphasize the importance of networking and network management. In fact, in recent years, cluster management has come to the

⁹ It has to be acknowledged that critics of the triple-helix, like Aylward and Turpin (2003), say that this concept ‘captures only part of the process’ (Ibid, 4) and that they suggest an ‘analytical territories approach’ instead, which focuses on ‘fluidity of action across local, regional and national boundaries’ (p.5) in a so-called economic space (contrary to a political one).
forefront as a key factor that determines cluster excellence (zu Koecker & Rosled 2010; Schretlen et al. 2011). However, measuring these effects is still a challenging task due to different data gathering methods in various countries and altering time frames for measurements. Also, one indicator does not define the performance of the whole network, but rather a collection of measurements provide a more comprehensive picture. Most commonly used in European Commission reports and industry studies, is a variation of the three indicators employment, innovation and productivity (see section 3.2.2).

Beyond the effect of cluster management, other theories suggest various factors for the success of a network. Some argue that for the attraction of outside companies and human capital, an anchor firm helps to make the cluster more popular and maybe even lure venture capitalists. Anchor firms are those companies that strategically source knowledge flows and have a number of relationships with customers and suppliers. More precisely, they attract new productive investments by external forms, both at vertical and horizontal levels (i.e. suppliers, key customers, complementors and/or rival firms)\(^\text{10}\). Anchor firms also ‘orchestrate cluster knowledge flows by strengthening their local network and providing a vision for uniting innovation, and promote new firms formation by fueling technological opportunities local start-ups may exploit’ (Baglieri, Cinici & Mangematin 2012, 245). However finding or creating such an anchor firm is not simple and entails risks. One could even go so far to suggest that a network could face disintegration when powerful anchor firms choose to relocate or vanish, a process witnessed in the Vancouver case (see section 5.4).

Another decisive factor, according to some researchers, is the attraction and retention of star scientists. They argue that those individuals are not only ‘carriers’ of knowledge (Glaeser 2004; Florida 2002, 2005), but also that they are attracting the attention of other academic scholars, policy and venture capitalists (Maier, Kurka & Tripll 2007). Some findings show that the stars themselves rather than their potential

\(^{10}\) Based on real estate concept, Agrawal and Cockburn (2003) define an anchor tenant as a large, locally present firm that is: (1) heavily engaged in R&D in general and (2) has at least minor absorptive capacity in a particular technological area. (Niosi & Zhugu 2010)
discoveries play a crucial role in the formation and transformation of high-tech industries, emphasizing their embodied knowledge, insight and energy (Zucker & Darby 2006; Maier, Kurka & Trippl 2007). But the findings also show that star scientists tend to move to clusters where other renowned scientists are housed, this means there are a few places that are ‘magnets’ while other clusters have to compete for these experts (Williams et al. 2004; Maier, Kurka & Trippl 2007). Singapore (see section 5.3) has used the attraction of star scientists as a key element to their strategy of making the biomedical community in the city-state more competitive. In the beginning, some experts came, attracted by the funding opportunities and up-to-date lab facilities, but eventually moved back to the US.

Finally, some reports emphasize the importance of an entrepreneurial culture being present in the region for a cluster to flourish. Malecki (1994) and Reynolds et al. (2001), for example, highlight the importance of the entrepreneurial climate in fostering economic development through the creation of new companies. They make the point that clustering leads to higher numbers of entrepreneurs, thus changing cause and effect (Rocha 2004). By saying that entrepreneurship needs clusters to be successful, instead of clusters needing an entrepreneurial culture to flourish, they reveal that cause and effect are difficult to test in this relationship. Testing whether clustered entrepreneurial activity generates more development than non-clustered is different from measuring cluster success based on the level of entrepreneurial activity. The latter argument highlights the fact that entrepreneurial culture affects the investment decisions of venture capitalists as well as the relocation of stakeholders into the region and thereby contributes to overall cluster performance (Majocchi & Presutti 2008).

Overall this discussion shows how complex the underlying factors for cluster success are and that these elements affect the cluster performance while the clustering itself impacts the attraction of anchor firms, star scientists and entrepreneurial culture.
This means these variables are associated both with the independent and the dependent variables and have to be controlled for when analyzing survey results\textsuperscript{11}.

**Collaborative and absorptive capacity through cluster management**

Based on the hypothesized relationship between cluster management and the level of collaborative and absorptive capabilities, the capacity framework is used to identify facilitator activities. The framework can break down ongoing cluster dynamics – initiated by the manager – into observable units, such as agreements, guidelines or networking events. These can then be analyzed separately or conjointly in terms of their efficiency and effectiveness.

As mentioned in more detail earlier (see section 2.2.1.), collaborative capacity entails purpose, communication, structure, and resources. All these elements are crucial for a network or cluster to connect multiple stakeholders (Lai 2011). Absorptive capacity, compared to collaborative capacity, focuses on the ability of a firm, a cluster or country ‘to integrate the existing and exploitable resources – technological opportunities – into the production chain, and the foresight to anticipate potential and relevant technological trajectories’ (Narula 2004, 6). To this, there are two dimensions: 1) the formation of linkages with extra-cluster sources of knowledge (i.e. extra-cluster knowledge base) and 2) the structural characteristics of the intra-cluster knowledge system (Bell & Albu 1999; Giuliani 2005). Overall, the collaborative and the absorptive capacity frameworks enable to name activities that enhance growth and productivity when a cluster manager is present. They are further, in a second step, connected to growth, as knowledge transfer among stakeholders and external players as well as the identification of knowledge gaps lead to more innovative activity (Giuliani 2005; Mytelka & Farinelli 2003; Cohen & Levinthal 1990, Baptista 1998; Matthews 2002).

\textsuperscript{11} A statistical control in a multivariate analysis means that ‘researchers choose variables that they expect to have a practically significant association with both the response variable and the explanatory variable’ (Agresti & Franklin 2009, 518).
3.1.2. **Operationalization**

Based on these findings and a pre-test in Vancouver, the survey research addressed facilitators, research and industry stakeholders and government actors in innovation-driven industries directly with a structured online questionnaire. The pre-test consisted of semi-structured interviews with stakeholders (see Appendix B for a list of interview partners) in the Vancouver life science industry with the goal of learning more about the idea of cluster management in the biotechnology industry and the relationships among researchers, government officials and entrepreneurs. It further served the purpose of identifying possible cluster challenges in advance and addressing them specifically in the survey questions.

There is no standardized methodology for comparing the competitiveness of clusters. In fact, there is not even agreement on a common definition of competitiveness, let alone how to measure it in a uniform way (van der Linde 2003). Most studies either look at clusters individually, such as a case study or focus exclusively on one particular industry, for example information technology. The survey, compared to a case or single-industry study, gives the opportunity to reach clusters around the globe, with different industry foci and diverse membership. Due to the vast online presence of clusters, which has increased during the last couple of years, it became easier to gather information on industry networks and their members. The survey was able to reach members quickly, directly and equally among the population sample.

<table>
<thead>
<tr>
<th>Population sample:</th>
<th>Triple-helix institutions in clusters from innovation- and factor-driven countries based on online search and industry reports.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable:</td>
<td>Economic performance indicators based on employment, innovation and productivity of the cluster.</td>
</tr>
<tr>
<td>Independent variables:</td>
<td>Existence/ Non-existence of a cluster organization, cooperative and absorptive capacity activities.</td>
</tr>
</tbody>
</table>

**Cluster sample**

The survey includes a large amount of the life science cluster population, which was identified in various government and industry reports and online. Although findings will focus on innovation-driven economies, which include countries/ states in Europe, North America or Australia, the survey targeted diverse biotechnology networks all over
the world. The websites set up by government or the cluster itself determined if an agglomeration of firms, universities and government input was in fact a cluster with life science focus. Cluster names such as ‘Medicon Valley’, ‘BioValley’ or BioAlps’ also supported the process of identifying possible survey recipients. Those websites were also the source for a list of affiliated institutions and firms and possible government programs supporting the network. However, focusing on online presence of clusters also implies that networks that are not ‘online’ are not included in the sample.

After determining the list of clusters, a sample was taken within each cluster, among government stakeholders, firms and research facilities. Especially the bigger clusters, such as the one in Boston or Medicon Valley, often host several hundred firms and many research institutions. Universities and government institutions usually appear in smaller numbers. Thus, mostly firms and some research institutions were randomly picked for those clusters where a list of all members was provided. To randomize the process, random.org\textsuperscript{12} was used. This service gives the opportunity to list all firms or research institutes and then generate a random list, from which the first ten to 15 entries were picked. This method accounts for the fact that bigger firms are often used as a flagship and therefore more prominently featured on the according website. Focusing on such flagship companies would lead to a dismissal of small firm perspectives and potential struggles within a cluster. Ultimately this steps controls for – at least in some clusters – a firm’s and research institution’s size and popularity.

In addition, the survey also included clusters in other areas than life sciences. Although not as extensively, the sample covers clusters in information technology, manufacturing, energy and environment. This gives the opportunity to prove that the hypotheses hold beyond the life science sector and it gives a broader understanding of clusters in general. There is the expectation in literature that the life sciences sector is defined by institutional idiosyncrasies and one-of-a-kind knowledge-intensive cooperation. As Breschi and Malerba (2005) point out, the life sciences are an unusual science-driven industry in that basic research done at universities and DBFs continues

\textsuperscript{12} Random.org offers true random numbers through atmospheric noise\textsuperscript{12}. The service was established in 1998 and was built and is being operated by Mads Haahr of the School of Computer Science and Statistics at Trinity College, Dublin in Ireland.
to be critical to the field’s development. Many other technology-based fields have their origins in university or corporate labs, but subsequent development is far removed from the initial discovery process. Another argument is that in life sciences typical demand features are absent. Including other areas in the sample will help to determine if the inner working of clusters really differs as much as predicted, based on the circumstances they encounter.

<table>
<thead>
<tr>
<th>~80\textsuperscript{13} clusters in innovation-driven economies</th>
<th>14 clusters in factor- or efficiency-driven countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Australia</td>
<td>4 Japan</td>
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<tr>
<td>1 Austria</td>
<td>3 Netherlands</td>
</tr>
<tr>
<td>3 Belgium</td>
<td>1 New Zealand</td>
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<tr>
<td>4 Canada</td>
<td>3 Norway</td>
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<tr>
<td>1 Czech Republic</td>
<td>1 Singapore</td>
</tr>
<tr>
<td>6 Denmark</td>
<td>1 Spain</td>
</tr>
<tr>
<td>5 Finland</td>
<td>5 Sweden</td>
</tr>
<tr>
<td>2 France</td>
<td>3 Switzerland</td>
</tr>
<tr>
<td>10 Germany</td>
<td>1 Taiwan</td>
</tr>
<tr>
<td>1 Hong Kong</td>
<td>4 United Kingdom</td>
</tr>
<tr>
<td>1 Israel</td>
<td>17 United States</td>
</tr>
</tbody>
</table>

\textit{Table 4 Location of survey recipients.}

Table 4 shows that the cluster sample is split up into two groups of innovation- and factor-driven economies. This helps to control for context-related and nationally and regionally embedded factors, such as the amount of funding for clusters or the number of highly qualified (research) personnel. Innovation-driven countries are those that focus on knowledge-intensive activities. Hence, where productivity and growth are ‘less based on the abundance of natural resources than on the capacity to improve the quality of human capital and factors of production, and to create new knowledge and ideas and incorporate them into equipment and people’ (Cooke et al. 2007, 27; David & Foray 2003). Those countries focus on the exploitation of new knowledge in order to create

\textsuperscript{13} some clusters spread across national borders.
Comparing cluster within the same group, offers higher levels of comparability, because all innovation-driven economies have 1) higher levels of GDP growth; 2) spend more resources on the production of knowledge (about 8% of GDP); 3) over 60% of the population ages 25-64 has completed upper secondary schooling; 4) high ICT investment (about 7% of GDP), and 5) the business sector is the main funder and performer of R&D (Godin 2006; OECD 2001). This shift towards innovation also changes the role of government. In these countries, ‘governments demonstrated strong tendencies of refraining to play the role of a ‘central actor’, but rather that of a ‘facilitator’’ (Goh 2005, 6; Hall 1986). This implies that government is taking a more informal, associational role in the interactive networks (Cooke et al. 2007; Lundvall 1992).

**Dependent variable**

The dependent variable is the economic performance of clusters. The data was acquired through external sources, such as the World Bank, the OECD, Eurostat and the statistical bureaus of the relevant countries. The performance measures include the unemployment rate, the number of patents in the according industry within that region/state, the rate of employees in medium/high-tech and knowledge-intensive sectors, the number of new enterprises established and for some of the networks, the OECD ranking measuring the performance of local business clusters in the knowledge economy.

The unemployment rate offers insight into the rate of new business formation or re-location, which is aided by learning, communication and commercialization – all elements connected to the collaborative and absorptive capacity framework. For example, spin-offs from universities or research organizations developing a new innovative product create new jobs and new venture capital investment opportunities for the whole cluster. If the unemployment rate is high, chances are that either certain types of job are not created or that the qualification of the personnel does not match the jobs offered. Also, high unemployment rates often hinder entrepreneurs to create new companies in that region, because if the start-up does not work out, chances of re-employment are lower. Thus, the unemployment number should be seen in relationship to the number of new enterprises established. A similar logic applies to the rate of
employees in medium/high-tech and knowledge-intensive sectors. This rate gives an indication of the number of highly-educated personnel in the region and the number of research institutes and firms offering these kinds of jobs. Both attractive features for venture capitalists and bigger firms to relocate. However, this measure does not indicate innovation efficiency.

Finally, the patents filed under the Patent Co-operation Treaty (PCT) are often used as an indirect measure of innovation activity. Patents indicate the technological progress of the firms located within the cluster. However, some patents or patent applications fail to be transformed into actual products, because 90 to 95 percent lack any market relevance and 99 percent do not bring profit (Stevens & Burley 1997; Jung et al. 2008). ‘Still, patenting is often necessary for many firms to keep their competitive advantage so clearly patents indicate something about the innovativeness of a firm’ (Denti 2013). However, many inventions ‘are not patented because they are not patentable or inventors may protect the inventions using other methods, such as secrecy, lead time etc.’ (STI 2013). And again, as for most measures that are used to compare different countries, differences in patent regulations make it difficult to draw conclusions based on this data (STI 2013). Overall, the patent rate is a data set which is readily available and collected on a regular basis for regions rather than at national-level and gives at least an indication for the innovative dynamics in the sector and location.

**Independent variables**

The concepts of collaborative and absorptive capacity define the independent variables for the survey. Because they are indicators for cluster capacity, which is hypothesize to be affected by a cluster management organization, the survey questions aim to intentionally disconnect these two ideas. This way clusters organizations themselves or participants in support of such an institution do not intentionally or unintentionally select these attributes as being true. The survey questions cover all

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14 The Patent Cooperation Treaty (PCT, June 19, 1970) assists applicants in seeking patent protection internationally for their inventions, helps patent Offices with their patent granting decisions, and facilitates public access to a wealth of technical information relating to those inventions. By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in 148 countries throughout the world (WIPO 2013).
collaborative and absorptive activities listed in the theory, as the following list shows. First, these are the questions connected to the concept of collaborative capacity of the cluster:

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are forms of communication you use within the network?</td>
</tr>
<tr>
<td>How well do you think are stakeholders generally connected among each other?</td>
</tr>
<tr>
<td>How well do you think are university researchers connected to companies?</td>
</tr>
<tr>
<td>How well do you think are companies connected to government officials?</td>
</tr>
<tr>
<td>How well do you think are government officials connected to university researchers?</td>
</tr>
<tr>
<td>Is there a (written) agreement among cluster stakeholders?</td>
</tr>
</tbody>
</table>

To measure the absorptive capacity of the cluster, the following questions apply:

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you in contact with stakeholders (e.g. research institutions or firms) from other regional industry clusters?</td>
</tr>
<tr>
<td>How would you rate your network members' overall connection to other clusters?</td>
</tr>
<tr>
<td>Do those outside-network linkages provide valuable information for work within the cluster?</td>
</tr>
</tbody>
</table>

Further, some of the questions specifically targeted the role of government by asking:

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you know of a government policy document targeting your industry cluster specifically?</td>
</tr>
<tr>
<td>Which legislation, regulation or policy acts as incentive for cluster development?</td>
</tr>
<tr>
<td>Please select the legislation, regulation or policy that poses a barrier to cluster development.</td>
</tr>
</tbody>
</table>

Another key question for establishing a relationship between a cluster organization and performance was: *Can you identify or are you a leading institution within the cluster?* In this context, 'leading institution' is defined as a member of the cluster that gathers valuable information for members and brings stakeholders from industry, research and government together. This question purposely appears twice in
slightly different wording. It further determines if a cluster belongs into the group of ‘with cluster organization’ or without. The other question targeting the same issue is: *Does the cluster have a designated cluster organization/ manager/ facilitator.* Both questions are mandatory and one appears in the beginning and one in the end of the survey.

To control for the presence of an anchor firm, star scientists and a weak or strong entrepreneurial culture, the following questions were included in the questionnaire:

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does your cluster have a famous scientist (star scientist) drawing attention towards the network, which leads to more funding?</td>
</tr>
<tr>
<td>Does your cluster have or are you a successful firm (anchor firm) that draws in investors?</td>
</tr>
<tr>
<td>How strong is the culture that encourages new ideas resulting in a business (entrepreneurial culture) in your cluster?</td>
</tr>
</tbody>
</table>

An issue that was repeatedly addressed during the pre-test in the Vancouver case was the lack of evaluation to inform stakeholders and government which initiatives are working and what support is needed. To address this aspect, the survey asks:

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you evaluate the cluster's competitiveness?</td>
</tr>
<tr>
<td>How are achievements by you and other stakeholders evaluated?</td>
</tr>
<tr>
<td>Who evaluates the performance of the overall cluster?</td>
</tr>
<tr>
<td>How often do you see evaluations taking place?</td>
</tr>
</tbody>
</table>

**Descriptive variables**

Questions concerning descriptive variables include the ones targeted at the name and region of the cluster (locational variables), the categorization of the recipient as a firm, cluster organization, research institutions, government department or technology transfer office and the industry sector. In more detail, these are the questions covered in the survey:

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am located in...(City/Town; State/Province; Country)</td>
</tr>
<tr>
<td>I belong to the following stakeholder group...(company; cluster organization; research institution/university; government department; technology transfer office; non-profit organization; Other (please specify))</td>
</tr>
</tbody>
</table>
Which sector is the network mostly operating in?

The answers to these questions are not connected to the causal relationship, but help later to categorize the clusters into different groups, such as different regions in the world and the separation of various stakeholder groups such as cluster facilitators or companies.

Summing up, the expectation is that cluster facilitation is something that is present and valued throughout different industries in countries all over the world and that the longer a network manager is in place, the more activities connected to absorptive and collaborative capacity are generated, the better the performance of the cluster.

**Possible survey limitations**

The analysis of network formation in this study is static, because the survey only measures one point in time. This might be seen as a limitation to some, especially those that believe that clusters go through a typical life cycle where they reach their maximum competitiveness after a certain period of time. But a meta-study of cluster demography by van der Linde (2003) found that no such evolution exists. Another limitation that has to do with the static set-up is that the cluster organization might have a larger effect, the longer it is in place. The duration of the existence of a cluster organization is difficult to track based on cluster records or online presence, due to the fact that often one institutions slowly takes over the role of cluster management and is only announced as such years later. Since the clusters will not be examined at several points in time, there was a question in the survey asking for the duration of cluster management to determine if there is a connection.

**3.2. Case study research**

The case study research in the following analysis is used to understand the complexity of the relationships between stakeholders, government and the facilitator. It explores the linkages between cause and effect, namely cluster management and performance levels and aims to understand the issue of cluster facilitation in general
The goal of the case studies is to capture the dynamics of each network in depth (Su & Hung 2009).

**Case selection**

To control for context-related and nationally and regionally embedded factors, such as the amount of funding for high-technologies or the number of highly qualified (research) personnel, the analysis again taps into the group of ‘innovation-based’ or knowledge economies. The 35 countries in this category include:

<table>
<thead>
<tr>
<th>Innovation-driven economies (35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
</tr>
<tr>
<td>Austria</td>
</tr>
<tr>
<td>Bahrain</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>Cyprus</td>
</tr>
<tr>
<td>Czech Republic</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Finland</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Greece</td>
</tr>
<tr>
<td>Hong Kong SAR</td>
</tr>
<tr>
<td>Iceland</td>
</tr>
<tr>
<td>Ireland</td>
</tr>
<tr>
<td>Israel</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Japan</td>
</tr>
</tbody>
</table>

*Table 5 Innovation-driven Economies (WEF 2011, 11).*

Based on the above list of countries, the case choice was motivated by two further factors: First, the variation of the independent variable, cluster management, and secondly, the cluster had to belong to the group of emerging rather than established ones.
Established versus emerging clusters

When studying life science clusters, Boston or San Diego seem to be an obvious choice due to their past success. However, there are different types of clusters and the systematic use of cluster management for better performance does not apply to all of them. Past research offers different categories clusters can fall into (see list below), but the underlying logic seems to be the same, that is, some clusters evolve spontaneously and take shape gradually over extended periods of time, while the success of others is triggered by an act of government enacting changes in policies targeting a specific region or sector. The list of the types of cluster (evolution) includes:

- organic process of clustering vs. engineered process (Andersson et al. 2004)/ spontaneous vs. policy-driven (Su & Hung 2009)
- S curve with the four stages being latent, developing, established and transformational (Williams 2005)
- established vs. emerging clusters (JLL 2012)
- Five-stage model with potential clusters, latent clusters and working cluster (Enright 2003)

Long-established networks, such as the ones in Silicon Valley, San Diego or Boston belong to the spontaneous and organic group of clusters. Here, the successful network is the product of the collective behaviour of individuals and firms within a regional economy as opposed to coordinated efforts by government to facilitate an industry in a specific area (Casper 2007). Thus, the group of organic clusters does not reveal any tools or mechanisms government or cluster management could use to further the innovative development. And in fact, ‘even though some clusters develop in a purely organic and laissez-faire manner through the cluster life cycle, most clusters grow with the support and intervention of cluster facilitators’ (Ingstrup & Damgaard 2013, 560).

For San Diego, for example, Casper (2007) shows that network ties were initially created by a small cadre of former Hybritech managers that developed new companies in the region. ‘These new firms initially were linked through their former ties to Hybritech, but soon developed a shared labour market pool that helped consolidate and then expand a viable network backbone for the San Diego biotechnology industry’ (Ibid, 453). Combined with access to the local universities and technology, the small network was able to evolve into a world class hub for life sciences. However, this shows that the cluster in San Diego was a rather rare event and says little about the formation of other clusters.
Additionally, cluster management has a significant impact on the speed and scope by which clusters develop (Sölvell et al. 2003; Ingstrup & Damgaard 2013).

Following from this, the case selection focuses on emerging, policy-driven clusters in innovation-driven economies with a variation of the independent variable, cluster management. Further influenced by time and financial constraints, the selection of the cases is pictured below and includes Medicon Valley (Denmark/ Sweden), Chicago (Illinois, US), Singapore and Vancouver (British Columbia, Canada).

![Figure 5 Case selection.](image-url)

The four quadrants show the continuum of more or less cluster management and the levels of government involvement. Thereby, Medicon Valley and Vancouver represent the polar types of the management spectrum. Medicon Valley has a clearly identified cluster facilitator and Vancouver has no cluster management, while both have some form of government involvement, ranging from more to less. Chicago and Singapore further highlight the range of cluster management, falling in between and into the upper right quadrant of medium to less facilitation and higher levels of government
involvement. The lower left quadrant remains empty, because government involvement is an integral part of emerging clusters. Emerging clusters are those that are driven by policy to find a place in the market. They are often recreated according to the famous example of Silicon Valley and did not appear spontaneously or organic. The study only includes these ‘second generation’ clusters in order to draw lessons for future cluster development. Organic clusters, such as Silicon Valley or Boston, could be found in the lower right quadrant of Figure 5, as they had no to little government involvement and only limited cluster management – mostly based on individual technologist-managers (Moore and Davis 2004). Another reason why the lower left quadrant remains empty is the fact that there are currently no clusters identified by the literature that show signs of a strong cluster management model with little government involvement. In fact, these two often go hand-in-hand.

Overall, the sample taken is not random, however it reflects the variation of cluster management and each case fulfills the criteria specified earlier: each network falls in the category of ‘emerging clusters’ and represents one part of the globe. Medicon Valley, which is a life science cluster combining stakeholders from Denmark and Sweden, represents network management embedded in a multi-level government system. This case is similar to many European countries, as the EU currently trains and benchmarks cluster management – making this tool more visible in the European Union. Illinois has less, but very targeted government involvement. It fosters an entrepreneur-driven culture through a dedicated innovation and technology office as well as connects with a network organization. This is also reflected in many US clusters. In Singapore, government involvement in terms of funding and organizing the life science network is high. This is true for most of Asia, as governments are trying to fast-track the high-tech industry development in their countries.

Selection of interview partners

In life science especially, products have their origin in the laboratories of universities and research institutes and results are commercially distributed by small- and medium-sized companies and multinationals. Therefore, a connection between research and industry is vital. Stakeholders also depend on favourable framework conditions for the cluster created by government policies, such as tax breaks or
immigration legislation. Based on this, stakeholders were targeted according to the triple-helix structure, which consists of research institutions, companies and government departments (Etzkowitz 2003). The 30 interviewees in the according cities of Copenhagen, Chicago, Singapore and Vancouver were targeted based on a list of stakeholders involved in the cluster. Through online research, CEOs, Directors and Presidents were identified and contacted. Interviews were set up with those that were willing and had the time to talk to me during the time I visited each city. Vancouver served as a pre-test for the type of questions developed for the semi-structured interviews.

Questions

The collaborative and absorptive capacity framework served as a guideline for the development of the questions, based on the elements of purpose, structure, communication, resources, intra-cluster and extra-cluster knowledge system. Those elements were explicitly targeted in the interviews to find the connection between cluster management and the heightened levels of capacity. The interviews were semi-structured and consisted of three parts. The first couple of questions addressed the position or institution the interviewee was working in and their relationship to the overall network. Often, this led to question about the current assessment of the cluster and the (government) strategy in pursuit of successful networking. In the following, the questions became more detailed referring to the capacity framework, asking about communication channels, funding opportunities and connections to other clusters. Lastly, the interview included questions about the future of the network, focusing on possible improvements, the competitive advantage and a future outlook.
4. Survey data of cluster facilitation

The online survey\textsuperscript{16} targeted about 1400 stakeholders of life science, energy, ICT, environmental and manufacturing clusters around the world with a structured questionnaire of about 30 questions conducted in English. The response rate was 9.2%. Due to the low rate of responses, all results have to be treated with caution, as a high rate of non-response creates a heightened probability of statistical biases (Tomaskovic-Devey et al., 1994). Also, the data can only complement findings from the cases and picture trends rather than give conclusive results on the relationship tested.

The number of responses can be attributed to several factors. First, the ease of access to creating surveys and spreading them online leads to over-surveying.

Over-surveying in a growing number of areas means that employees are flooded with questionnaires (Weiner & Dalesio, 2006). The result is a large number of target individuals or firms who are fatigued and therefore refuse to respond to non-essential questionnaires. (Baruch & Holtom 2008, 1142).

Especially in firms, the email addresses made available online are often not accessed by those in leading positions, but rather by an assistant or secretary who has orders to mark surveys as spam or delete them completely. Some companies also have a policy of not filling out surveys all together – this is true for big pharmaceutical companies, as personal interviews have confirmed.

Looking at the distribution of responses across groups, the survey results show that the stakeholders are almost equally distributed (~30 per group) across companies,

\textsuperscript{16} The questionnaire was designed and distributed through ‘surveymonkey’, which is a provider of web-based survey solutions. Participants were invited via email and received a personalized link, which gave them the opportunity to return to a partially completed survey. The completion of the survey for participants took about 20 minutes. The timeframe for the survey was four months, in which the initial email and according reminders to either start or complete the survey were sent out. There was no incentive given for those that completed the survey.
cluster organizations and research institutions or universities, while there are fewer government actors and non-profit organizations (~15 per group). This trend has to do with the fact that for most clusters more firms and research institutes were contacted, as they were easier to find and reach. However, this does not apply to cluster organization, because there is usually only one per cluster. From those that filled out the survey, 57 indicated that a cluster organization was present in their network, compared to 22 answering with 'no' and some with 'don’t know'. Additionally, the survey population was mainly from Europe (~64 responses) and North America (~32 responses). In sum, the population shows that results will be mostly applicable to Western states and that individual evaluations are mainly from the perspective of companies, cluster organizations and research institutions.

4.1. Role of the cluster organization

According to the clusters indicating that a facilitator was present, the following trends can be summarized. First, most respondents (excluding the cluster organization itself) indicate that the cluster organization has been in place for several years and that the most important task performed is the organization of network meetings. In addition, as Figure 6 shows, all services listed in the questionnaire seem to apply to the facilitator’s responsibilities. This confirms the catalogue of services established based on the collaborative and absorptive capacity frameworks. All respondents indicate that the facilitator organizes networking meetings (87.9%) and most emphasized the linkages to other clusters, firms and research institutions (66.7%), as well as the provision of a communication platform (63.6%), the advice on funding opportunities (57.6%), the creation of new projects for cooperation (78.9%) and advertising the cluster on the (global) market (51.5%). Hence the expectation by stakeholders mostly meet what the cluster organization aims to offer for the network, which points towards successful implementation of the institution. These results also speak to the centrality of the cluster organizations within the networks, as stakeholders trust it with activities connected to networking.
Figure 6 Cluster management services ranked by stakeholders.
Further, the question asking for the effects of these services in the cluster clearly points to more networking within the cluster. Over 90 percent of the respondents said that, because of the cluster organization, there are better/stronger connection between cluster stakeholders followed by the indication of more meeting and more government attention (see Figure 7). Similar to the previous question, there is an overlap as to how stakeholders see the effects of the cluster organization and how the facilitator evaluates itself. The cluster facilitators themselves highlighted that their work leads to better/stronger connections among stakeholders (84.2%), to more meetings among stakeholders (78.9%), more government attention (78.9%) and stronger connections to other clusters (73.7%).

Figure 7 Effects of cluster management.
Based on the comparison of the self-assessment of clusters with and without cluster organizations, those with facilitation have more connections among each other. Stakeholders that reported having a cluster facilitator indicate that regular (42.1%) and even frequent (34.2%) personal connections exist, as well as contractual links (50.0%), organizational ties and third-party contact (34.2%). Clusters without facilitation reported mostly irregular links between university researchers and companies and between government officials and research institutions. The industry-government connection was portrayed as regular.

One striking difference regarding the effects of cluster management, is the discrepancy between the views of stakeholders and the cluster organization on its role to connect the network to other clusters. The facilitators rank their effect in terms of the linkages to other clusters relatively high (73.7%) while less than half of network members saw this service as important or effective (30.3%). Also, when asked about their connections to other clusters in general, 71.9% of stakeholders indicate that they are directly in contact with stakeholders from other regional industry clusters. Compared to clusters without cluster organization, this number does not differ, as 63.6% say that they have regular connections to other networks. The results indicate that in terms of making the connection to another cluster, the cluster organization might not play such a significant role as the facilitators themselves think it does. This has to do with the fact that more companies are becoming global and have branches around the world that are in touch on a regular base. Universities also more and more make an effort to establish collaborative research projects across borders. These connections often happen within a company or due to individual researchers that have moved from one cluster to another and it seems the presence of a cluster organization is not necessary to create those linkages.

The comparison between clusters with and without facilitation further shows that related to the communication channels used, the two groups differ (see Table 6).

<table>
<thead>
<tr>
<th></th>
<th>Clusters without facilitation</th>
<th>Clusters with facilitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most frequent communication channels</td>
<td>email (95.5%)</td>
<td>face-to-face and email (both 91.9%)</td>
</tr>
<tr>
<td>Government policy</td>
<td>no (45.5%), yes (45.5%)</td>
<td>yes (62.5%), no (28.1%)</td>
</tr>
<tr>
<td>document</td>
<td>Written agreement among stakeholders</td>
<td>Evaluation</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>no (60%), yes (30%)</td>
<td>mostly project-based (61.9%) – once a year/ every 2-3 years (both 22.7%)</td>
</tr>
<tr>
<td></td>
<td>yes (45.2%), no (38.7%)</td>
<td>project-based (50%), cluster-wide evaluation (43.3%) and industry reports (33.3%) – once a year (45.2%)</td>
</tr>
</tbody>
</table>

**Table 6 Comparison of clusters without and with facilitation.**

As part of the collaborative capacity framework, Table 6 gives several important pointers towards the difference in the networking dynamic in clusters with and without facilitation. Both types of clusters mostly communicate via email with other members, however, managed clusters also have regular face-to-face contact. The personal contact supports the exchange of tacit knowledge\(^{17}\), as this type of knowledge cannot be explained or coded, but has to be experienced or communicated face-to-face. Regarding government policy documents targeting the industry the cluster is in and the written agreement among stakeholders, the clusters with facilitation are at a slight advantage. 62.5% and 45.2% of the stakeholders in clusters with facilitation indicated that they have policy documents and/or written agreements.

According to the survey, the frequency and type of evaluation differs between the clusters with and without facilitation. While clusters without management mainly rely on project-based evaluation once a year or every two to three years, facilitated clusters portray a wider variety of project-based, cluster-wide and industry evaluation, which is done predominantly once a year. Project-based evaluation usually yields minimal results about the overall cluster, because it portrays one project, for example, between industry and university. Results also are not comparable, as projects differ in lengths, size, funding and goals. In contrast, cluster-wide and industry evaluations give a more complete picture of what is happening in the network. Industry evaluations are usually carried out by companies, such as PriceWasterhouseCoopers or Ernst & Young to assess the cluster’s performance based on external data and interviews. Cluster-wide evaluation...

\(^{17}\) ‘Interest in tacit knowledge stems from Polanyi’s (1956) argument that we frequently know a good deal more than we can express verbally. Explicit knowledge is highly codified, as in blueprints, recipes, manuals, or in the form of training. Tacit knowledge lacks such extensive codification (Nonaka & Takeuchi 1995)’ (Powell & Grodal 2005, 75).
and industry evaluation might also differ between networks, regions and countries, however, they make a variety of hard and anecdotal data available that can be used to decide on policies and give stakeholders and policy-makers a better idea of where the cluster stands within a country or even internationally. The role that the cluster organization plays in enabling those more comparable evaluations is that they animate stakeholders to collect and combine that data and make it available for possible evaluators or use it to understand current and future dynamics for own use. Such data is also a tool in negotiations with the government when talking about funding schemes for the coming years or attracting companies to the cluster by emphasizing favourable data for funding and entrepreneurial activity. Thus, the cluster organization has an interest in pursuing and supporting evaluation for two reasons, first, to advertise the cluster to investors and government officials and second, to identify gaps in funding or any related activity.

Another aspect to facilitation is the attitude of stakeholders towards accepting cluster management as a useful and helpful tool in the innovation process. In connection to the notion of social capital, without the trust in the abilities of the facilitator, the support structure will not be successful. Asking stakeholders in clusters with facilitation what they think makes a cluster successful, 71% said the cluster organization. Networking among stakeholders and funding from external sources also got a major amount of the responses. Interestingly enough, 50% of the members of cluster without management, indicated that they think facilitation would make their cluster more successful (see Figure 8). They also state that innovative research and external funding is part of cluster development.
Figure 8 Cluster success factors of network members without facilitation.

Overall, the survey supports the use of collaborative and absorptive capacity to identify the elements of facilitation. It also shows that the services cluster organizations offer are those expected and wanted by stakeholders. The only mismatch the questionnaire uncovered was that stakeholders mostly connect to other networks without the help of cluster organizations. This does not mean that the cluster management’s connections are not valuable – the opposite is true, as the Ambassador program in Medicon Valley will show (see section 5.1), managers can learn best practice models from other clusters for their own facilitation and uncover new projects.
4.2. Role of Government

Overall, the survey shows that government involvement is needed in many areas of cluster development, specifically for targeting framework conditions. These include infrastructure, education or tax policies. The expectation is that resolving such regulation bottlenecks will promote innovation (Anthony, Roth & Christensen 2002). This is supported by the survey results, which show that especially the university system, infrastructural policy and the education system act as incentives for cluster development (Figure 9). For example, increasing the availability of human capital through university system support is a way to encourage the creation of more innovative products and services.

![Figure 9 Incentives for cluster development.](image)

The top three policies hindering cluster development from a stakeholder perspective are current immigration (42.6%) and infrastructure policy (42.6%) as well as a lack of tax reductions (29.8%).
It is obvious that government is an integral part of innovative networking and that regulations and policies directly affect the cluster’s competitiveness. From a government standpoint, however, making decisions based on the needs of a specific cluster regarding immigration or infrastructure policies is not always possible. It takes inter-ministerial and inter-agency committees that design programs and national plans according to complex fields, such as biotechnology. For that matter, cluster management takes the crucial role of lobbying for and informing about a certain cluster, especially in regions or countries where several industry fields compete for attention.

4.3. Effects of cluster management on performance

The survey results sketch the preliminary trend that having a cluster manager enhances the levels of collaborative and absorptive capacity. But does that also – in a second step – affect performance? When looking at clusters that were rated as competitive worldwide as opposed to evolving or regionally/ nationally competitive, most of them answered that there was a cluster organization in place (Figure 10). These results have to be interpreted with extreme caution, as the competitiveness of the cluster is the subjective stakeholder evaluation and recipients from the same cluster are lumped together in one group. Still, the cases support that in functioning clusters, there seems to be an organization with a management function.
As pointed out, theory attributes part of that success to the presence of an entrepreneurial culture and the existence of an anchor firm and/or star scientist. Comparing competitive and non-competitive clusters based on these factors yields the following results (see Table 7).

<table>
<thead>
<tr>
<th></th>
<th>Non-competitive clusters</th>
<th>Competitive clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>entrepreneurial culture</td>
<td>mostly 4 (35.7%)</td>
<td>3 (31.9%) to 4 (34%)</td>
</tr>
<tr>
<td>(1 – very weak to 5 – very strong)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>anchor firm</td>
<td>yes (35.7%); no (50%)</td>
<td>yes (59.6%); no (27.7%)</td>
</tr>
<tr>
<td>star scientists</td>
<td>yes (28.6%); no (57.1%)</td>
<td>yes (55.3%); no (38.3%)</td>
</tr>
</tbody>
</table>

Table 7 Comparison of non-competitive and competitive clusters.

Both groups do not seem to differ based on their entrepreneurial culture, which is defined as a culture that encourages new ideas resulting in a business. There is a slight

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18 These answers only consist of questionnaire recipients that categorized their cluster as ‘world’s strongest’, ‘among the world’s 3 most competitive’, ‘among the world’s 10 most competitive’ or ‘internationally significant’.
difference in the existence of anchor firms and star scientists, however, cause and effect cannot be clearly determined. Because most competitive clusters have a cluster organization, it is unclear if facilitation drew firms and scientists to the cluster or if they existed before that. A quick look at the numbers for clusters with and without facilitation compared to Table 7 above shows that clusters with facilitation are more likely to have an anchor firm (56.3% vs. 28.6%), but don’t differ in the presence of star scientists. This points towards the fact that cluster management might be connected to anchor firms, however has no effect on the presence of star scientists. One explanation for this could be that scientists are attracted by structural elements of the region on which the cluster facilitator has no immediate effect. As Zucker and Darby (1996) point out:

The United States, with a strong comparative advantage in the higher education industry as well as many of the key discoveries, is the primary producer of star scientists in the world. Despite the significant outflow of outstanding young scientists who first publish in the United States before returning home, America has managed to attract enough established stars to achieve a small net in-migration. The major losers of key talent have been Switzerland, the United Kingdom, and Canada. Field work has indicated that Swiss cantons have enacted local restrictions inhospitable to biotechnology and that the United Kingdom has systematically reduced university support and deterred other entrepreneurial activity by subsidy to favored NBEs. The Canadian losses presumably reflect the ease of mobility to the particularly attractive U.S. market. (Ibid, 12715)

This reiterates the importance of the education system and national regulation in connection to high-tech industries. It also points towards the fact that government has a larger impact on the relocation of star scientists than the cluster organization or even the cluster itself, as funding and regulation are a big part of the decision where to allocate research facilities. In the interviews, researchers also pointed out that the way universities handle intellectual property rights based on national laws also affects scientists in their decision. Anchor firms, on the other hand, are more drawn to the potential of the research happening in the cluster and the ability to access the cluster with minor adaption costs. A cluster organization can be such a point of entry, as it is able to help firms that decide to relocate. As the Chicago case will highlight, the Illinois Biotechnology Industry Organization, as the facilitator, and the Government Office of

19 New Biological Entities.
Entrepreneurship, Innovation and Technology sat down with potential companies and gave them an overview of the opportunities in the cluster as well as tailored tax incentives for stakeholder needs. In the survey, those with an anchor firms also had a high level of entrepreneurial activity (mostly ranked at 4\(^20\) – 42.1%), while those without mostly ranked themselves somewhere at the average level of 3.

For most clusters in the survey, the facilitator has been in place for more than five years (36.4%) or one to three years (33.3%). 21.2% reported that the facilitator manages the cluster for three to five years and 9.1% had a cluster organization in place for under a year. Based on the clusters that indicated having facilitation, the following link to performance across industries can be trended compared to those without cluster management. This is only a snapshot of clusters with varying length of facilitation, but a trend is clearly visible: with a cluster management in place, there are less low-performance and more high-performance and nationally competitive clusters (see Figure 11).

\(^{20}\) Scale from 1 (very weak) to 5 (very strong).
Figure 11 Link between length of facilitation and cluster performance.

The sample is based upon 42 clusters that were part of the survey and indicated the (non)existence and length of cluster facilitation. The graph includes clusters from all over the world, such as Europe, North America, Asia and Africa. Also, they vary in industry. The survey respondents indicated that they belong to the manufacturing, ICT, environment, energy, food production and life sciences sectors (a complete list can be found in Appendix A). The independent variable of length of facilitation was collected through the questionnaire, while the dependent variable of performance was acquired through external sources, such as the World Bank, the OECD, Eurostat and the statistical bureaus of the according countries. The performance measures included the unemployment rate, the number of patents in the according industry within that region/state, the rate of employees in medium/high-tech and knowledge-intensive sectors, the number of new enterprises established and for some the OECD ranking measuring the performance of local business clusters in the knowledge economy. Clusters fell into the high-performance category if they had high levels of patent count, firm creations, medium/high-tech and knowledge-intensive employment. Also, being ranked by the OECD gave further indication for the international recognition in that
sector. The unemployment number and the general employment in knowledge-intensive occupations gave context to the regional dynamic of finding a new job if a new start-up fails – which it often does – or researchers decide to switch over from university-linked labs to industry. ‘Nationally competitive’ were those clusters known within the country, but not recognized beyond that. They also compared only average in their data on patent count, employment and firm creations in relationship to that industry. The low-performing clusters were those that compared badly across all or most indicators and were just starting out or not gaining momentum in building up the industry in that area\textsuperscript{21}.

In more detail, the categories were established based on the relationship between indicators rather than the quantity of, for example, firm births. Hence, each account has to be interpreted in relationship to the other indicators: If many new firms are created, but unemployment is high and the patent count is low, the cluster remains in the ‘low performance’ category as the availability of human capital does not match the firms created and new firms are not productive in terms of patents. Johannesburg is such an example (see Appendix 1). On the other hand, if firm creation numbers are low, a large number of patents and high levels of high-tech employment can make the cluster internationally competitive or ‘high performance’. The life science cluster in Uppsala, Sweden is one of those networks. Further, making the list of the OECD ranking indicates that the cluster is internationally recognized. The OECD lists some of those clusters according to their composite indicator, which is based on the arithmetic mean of six local indicators grouped together: ‘an indicator of entrepreneurialism (share of firms less than 5 years old); an employment growth indicator (average rate of employment growth); two economic growth indicators (average rate of turnover growth and average return on total assets); two financial viability indicators (average liquidity ratio and average solvency ratio)’ (Temouri 2012, 30). Thereby, for a small number of clusters, the composite indicator is limited to the first three indicators, due to constraints in data availability. Overall, any ranking or categorization of clusters raises a set of additional methodological issues, as there is limited availability of indicators, and their

\textsuperscript{21} For further elaboration on some of the challenges connected to these performance indicators, see section 3.2.2.
comparability is often limited. In sum, the loose categories used in Figure 11 provide a trend among clusters according to their length of facilitation and performance levels.

An interesting aspect that came to light through the survey, was the fact that the internationally well-known and highly successful Boston life science cluster has had a cluster facilitator for over five years. Further research revealed that the Massachusetts Biotechnology Council (MassBio) has taken on the role of a cluster organization. MassBio was founded in 1985 and, on its website, points out that it is an association consisting of more than 600 biotechnology companies, universities, academic institutions and others dedicated to advancing cutting edge research and is currently the leading advocate for the Bay State’s life sciences cluster (MassBio 2013a). The non-for-profit organization is connected to all stakeholders of the network, including government, research institutes and companies. On the policy side, MassBio advocates for ‘developing and supporting initiatives at the local, state and federal levels that will ensure we continue to not only compete, but lead’ (MassBio 2013b) and also informing members on latest developments in politics and policy (Ibid). The organization also has a political action committee (PAC) focusing on life science issues. MassBio offers various innovation services, such as ‘link[ing] new entrepreneurs and founders with seasoned biotechnology professionals to provide industry expertise, evaluation, and guidance as a means to help commercialize new ideas’ (MassBio 2013c). The cluster in Boston having facilitation is especially interesting, because it has always been the example for organic, bottom-up cluster development throughout the literature (see for example Owen-Smith & Powell 2004). The recent developments show that the network did not rest on its laurels of early success, but rather took on a course of creating a strategic and targeted initiatives to keep the cluster going. Currently, the cluster organization is looking to combine all parts of the life science industry to push the cluster towards more coherent and goal-oriented action in collaboration with government, industry and research stakeholders. This finding also reiterates the fact that facilitators grow into a management position over a longer period of time. MassBio has been around since 1985, but only took on a more prominent role in the last couple of years.
4.4. Cluster evaluation challenge

Going back to the connection between facilitation length and performance, these results also raise the question of how to evaluate clusters. Collecting the data for the dependent variable of performance confirmed that there is hardly any coherence with variations in governance levels, such as the state/region, municipality or district, time frames and the numbers are often calculated in dissimilar ways that make a comparison even harder. Also, most official reports by the OECD or Eurostat focus on established clusters, such as the ones in Boston, San Diego or Oxford. Only recently, the focus has shifted towards networks, for example, in Asia. There is also no generally-applied rule on what the basic measurements for cluster performance should be. In fact, the soft data\(^{22}\), which are self-reported by many clusters, can fall into the category of being explanatory and responsive at the same time. Further, for hard data\(^{23}\) there is a notorious chicken-and-egg problem when it comes to measurements such as R&D or venture capital funding, inflow and outflow of personnel or the GDP contribution of the sector in that region. For example, did the venture capital funding increase due to better performance, or is the investment an indication for the performance level itself? Has the inflow of personnel to do with the recent attraction of a big company based on high performance or is it product of cluster management and policy attraction initiatives and therefore a measure in it of itself?

There is also an ongoing discussion about the relationship between measurements taken regionally, in the metropolitan area or for the cluster itself. For example, the OECD Scoreboard bases its performance measures on firm data. ‘This has the advantages of enabling presentation of data for functional cluster areas built up from municipality level rather than larger regions, enabling more timely economic analysis and providing information on financial performance not available from standard sources’ (Temouri 2012, 5). However, these measures are prone to bias due to possible over-

\(^{22}\) Soft data is self-reported or anecdotal data, which has the advantage of being timely and it can be collected in high frequency, however, they are also less good at forecasting change (European Commission 2010).

\(^{23}\) Hard data is usually compromised of official statistics and gives actual results, however its collection usually suffers a time lag and not all data is comparable due to different times and forms of collection within each country.
representation of some bigger companies. In comparison, the Global Innovation Index\textsuperscript{24} uses country-wide data for output performance, focusing on knowledge creation, impact, diffusion as well as intangible assets, creative goods, services and online creativity (GII 2013). But, national information is difficult to obtain and is often provided with a time-lag. Further, some clusters cross sectoral borders, which means the data only captures part of the network’s performance. Thus, each set of indicators has its advantages and disadvantages, however as long as there is no agreed-upon set of soft and/or hard data, no globally comparable evaluation of clusters can be done.

In sum, the cluster research has a general data collection and thus an evaluation problem. The European Union recently published a report which summarizes the attempts of different countries and researchers to capture the performance levels of clusters within their country and the results could not be more different. They range from focusing on the strengths and professionalism of the cluster organization to using an estimate of potential cluster growth for evaluation (zu Koecker & Rosted 2010). This is also related to an unclear conceptual basis on how cluster success comes about – with no theoretical basis to build on, the indicators become interchangeable and arbitrary at best. As Williams (2010) states, ‘measuring effectiveness is a particularly complex challenge in collaborative settings in which outcomes are likely to be the product of a mixture of structural and agential factors’ (Ibid, 26). Adding to that is the fact that there is a lack of clarity regarding the definition of cluster management and what ultimately constitutes ‘success’ of a cluster.

The following combination of more in-depth case study research and the survey aim to provide a viable option for identifying the elements of cluster management. Connecting these specific activities of facilitation to performance outcomes can then feed back into the pre-existing attributes of successful cluster managers. The research also reveals that hard data performance measures make clusters more comparable,

\textsuperscript{24} ‘Cornell University, INSEAD and the World Intellectual Property Organization (WIPO, a specialized agency of the United Nations) co-publish The Global Innovation Index (GII), now in its sixth edition. The GII recognizes the key role of innovation as a driver of economic growth and prosperity and acknowledges the need for a broad horizontal vision of innovation that is applicable to both developed and emerging economies, with the inclusion of indicators that go beyond the traditional measures of innovation (such as the level of research and development in a given country)’ (GII 2013).
however they are only part of the 'output story'. The location of the cluster does affect its performance. As the following case studies will show, for example, Chicago is struggling to compete against the attractiveness of the coastal areas, but at the same time is able to connect with those stakeholders and create knowledge-spillover. Singapore does not have geographically close competitors, but also has no critical mass of researchers or firms in other networks close by. Both situations play out differently in performance measures, as Chicago has many new firm creations while Singapore is able to attract high-ranking researchers.
5. Cluster facilitation in life sciences

The following case studies extend the basic knowledge gained through the survey. While the questionnaire indicates that facilitation does exist across different industries and a variety of countries, it also hints towards the fact that management positively impacts cluster development and that those activities match the elements of collaborative and absorptive capacity. The case studies built on this and reveal further detail about the relationships among stakeholders, namely government, industry and research institutes and characteristics as well as variations of the facilitation model. In fact, the information gained through the interviews and based on policy and industry reports reveals three variations of facilitation, which are summarized at the end of each case and discussed in the analysis (Chapter 6).

The following cases are all clusters in the life science field. They display a variation of cluster management models from strong and clearly-identified (Medicon Valley) to no cluster management (Vancouver). The case studies also represent different parts of the world, as they are located in Asia (Singapore), North America (Chicago, Vancouver) and Europe (Medicon Valley). The order of the cases is based on the degree of leadership in the network, starting with strong to weak – Medicon Valley, Chicago, Singapore and Vancouver. The presentation of each case is similar, starting out with a general introduction of the key players, such as government departments and the cluster manager, followed by a more detailed assessment of the elements of the collaborative and absorptive capacity framework and a detailed facilitator description. Each cluster analysis also includes an outline on what the current struggles are and the future key questions related to that specific set-up.
5.1. Medicon Valley (Øresund Region, Denmark/Sweden)

The Medicon Valley cluster is located in the bi-national Øresund region, which spans greater Copenhagen in Denmark and Scania in southern Sweden, including the university town Lund and Sweden’s third biggest city, Malmö (Asheim & Moddysson 2008). Both parts of Denmark and Sweden have a history of life science research and the settlement of large pharmaceutical anchor firms like Novo Nordisk or Lundbeck. Scania developed a basis for life sciences through the early presence of Astra (now AstraZenca) and Pharmacia (now owned by Pfizer), which located parts of their research activities in Lund. In Denmark, similar developments took place, which led to the decision in 1994 to actively stimulate bi-national regional development in life sciences (Moodysson, Coenen & Asheim 2010). The construction of the Øresund Bridge in 2000 also fed into the favourable conditions for combining both regions into one cluster, which the Oresund committee branded as ‘Medicon Valley’ – based on its famous predecessor ‘Silicon Valley’. However, integrating both sides, even with the support of a bridge for better commuting, was and still is a difficult undertaking.

The Øresund Region

‘The Øresund Region’ is the chosen label for a cross-border area spanning the Metropolitan Copenhagen Region (governed by the co-ordinating cross-county body HUR) in Denmark and stretching into southern Sweden, including the province of Scania (governed by a regional council). In total the area has a population 3.2 million inhabitants and a strong concentration of universities, research institutions and science parks. An ‘Øresund Committee’ was established in 1993 by the Greater Copenhagen county authorities, (the counties of Copenhagen, Frederiksborg and Roskilde, and the municipalities of Copenhagen and Frederiksberg) as well as regional and local authorities of Scania (Sweden). In 1999 the membership was extended to comprise

25 In order to attract researchers and firms to the region, both governments – Danish and Swedish – and the Capital Region of Denmark, pushed for the Øresund bridge, connecting Copenhagen with Skåne (the Southern part of Sweden). This opened up new possibilities for both sides of the border in terms of living in one country and working in the other and connecting to universities and businesses on the other side of the water. It is a ‘new configuration of links and networks between cities – this can be seen in the very fact that the bridge is not built where the distance is the shortest, rather it is built the major agglomeration is found’ (Jensen & Richardson 2004, 141). The region has become known and branded as such and is also advertised by government for its combination of metropolitan cities, nature and living quality. Another label the Øresund Region was given is ‘human capital’ – this is the explicit attempt to add a softer dimension to the project by emphasizing the way of life rather than infrastructural aspects (Jensen & Richardson 2004).
neighbouring Danish counties outside the metropolitan area (Vestjælland, Storstrøm and Bornholm). The research environment includes the main universities of Lund and Malmoe (Sweden) and Copenhagen and Roskilde (Denmark), together with independent research institutions, such as the Wallenberg Neuroscience Centre, the Department of Biotech – Centre for Biological Sequence Analysis, the institute of Medical Biochem and Genetics and the Swedish Institute of Food & Biotechnology, as well as public hospitals where clinical research is a main competence. The Science Parks (Ideon, Medeon, Symbion and the Danish Science Park in Hoersholm) in Medicon Valley, of which Ideon Science Park is the oldest and largest in Scandinavia, house a number of small and medium-sized companies specializing in biotechnology and IT and also have a strong profile within biotechnology.

**Figure 12 The Øresund Region (Maskell 2004, 171).**

The Medicon Valley Alliance (former Medicon Valley Academy) was created to meet the integration challenge by Lund and Copenhagen universities as an EU Interreg II Project26. ‘The rationale behind the initiative was to stimulate the formation of a cross-border life science region, by promoting local integration and cross-fertilization between industry and academia’ (Moodysson, Coenen & Asheim 2010, 362). The goal further was to spur development and support interaction between private companies, universities, hospitals, science parks, research institutions and providers of knowledge-intensive services (Maskell 2004). Since then, the Medicon Valley Alliance (MVA) has updated its mission from focusing on regional integration to active networking and collaboration support and developed new methods to support the cluster. In 2000, the actual branding of ‘Medicon Valley’ was intensified by an online platform, a structural approach for the region and the ambassador program, which invites and sends out people to other clusters to learn27. Since 2004/2005 – according to interviewees in industry and at MVA – the level of cooperation and communication at decision-making level went up. In other words, at this point MVA earned enough trust and established a core node position in the cluster so that big companies and government would be

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26 Interreg II is a European Program funding cross-border initiatives, which was introduced by the Commission in 1990. It existed from 1994 to 1999 and consisted of three strands, strand A focused on ‘cross-border cooperation’; strand B on the ‘completion of energy networks’, and strand C on ‘transnational cooperation’. The Oresund project fell under strand A and received €14 million [~$18.3 million US dollar] in EU contributions (LRDP Ltd 2003).

27 Currently, MVA itself has ambassadors in Boston, Korea, on the West Coast in the US and there will be one posted to China soon. As one interviewee points out, ‘because being posted, being there on a day-to-day basis, they connect, they create personal relations with venture capitalists’
involved on a regular basis – 'the surroundings were ready to see MVA stepping up to a new role'. This is a crucial step in the establishment of MVA as a facilitator especially due to its competition with inward investment agencies\(^{28}\). Also, the regularity and frequency of meetings at MVA, including government, industry stakeholder and universities, led to the maturing of people on the board in their understanding of the networking dynamics in the cluster and thus to more qualified discussions as one interviewee points out. The following visibility of the cluster then led to a self-perpetuating process in which Medicon Valley became more visible, attracting more talents and investors, leading to more people working with MVA to be part of the cluster's development. The growing size and representation function of MVA then gave it the power to coordinate and advertise the cluster.

MVA is funded by the three regions that belong to the Øresund partnership – Capital Region of Denmark, Region Zealand and on the Swedish side, Skåne – the universities, such as the Technical University of Denmark (DTU), Copenhagen and Lund University and most of the (small) biotech companies\(^{29}\). This money accounts for about 50 percent of the MVA budget, while sponsorships and EU funding make up the other half. The constant struggle described by the Capital Region and MVA is that, on the one hand, it is difficult for MVA to continuously prove its value to individual companies or the universities as a lot of the work involves networking support, which can hardly be measured in exact numbers or output. On the other hand, the Capital Region of Denmark aims to make MVA a self-sufficient organization in the sense that it relies on membership fees and sponsorships instead of government funding. The region points out that this is the only way that the idea of MVA can prove to be valuable to the cluster and it gives government the opportunity to evaluate the facilitation process.

The work that MVA currently does mainly involves the following activities:

- Matching possible partners,
- 'being out in the real world',

\(^{28}\) Inward investment agencies such as 'Copenhagen Capacity' or 'Invest in Skåne' promote investments to the targeted region by providing advice and services for expansions. Compared to MVA, the agencies compete for venture capitalists interested in the region or expansion of companies instead of bringing collaborators together.

\(^{29}\) The annual membership fee starts at €740, about 976 US Dollar.
• Going abroad through the ambassador program,
• Evaluating framework conditions and infrastructure,
• Networking activities,
• Lobbying for the cluster,
• Connecting companies to talent pools,
• Translate regional/national strategies into action,
• Synchronize different agendas,
• Keep up the momentum, and
• Keep track of opportunities.

These are activities other stakeholders attributed to Medicon Valley Alliance during the interviews. Especially the networking possibilities through common board meetings and MVA’s connection to both, stakeholders ‘on the ground’ – meaning researchers and small firms – as well as its link to internationally based players through the ambassador program were emphasized. This includes the match-making of partners within and outside of the cluster. MVA itself outlined daily activities, but also strategic plans that address the currently most pressing issue of how to stay competitive and retain key stakeholders, such as Novo Nordisk30, within the cluster.

MVA’s day-to-day activities include creating opportunities for Danes and Swedes to meet and partner up business- or research-wise. These meetings can take different forms, it could be scientists from DTU giving a scientific talk about new developments in a certain sub-field of biotech to firms or an informal meet-up for people to connect. Another important activity is lobbying politicians ‘based on facts and through the media’. This implies assessments of the cluster developments and the publication of strategic visions. As one of the most important services, MVA describes connecting companies to the ‘talent pool within Denmark and Sweden – for example at universities – but also

30 Novo Nordisk, as a healthcare company and a world leader in diabetes care, is an important magnet for human capital and investor in the Øresund Region. For example, in the beginning of 2013, the company invested an additional 380 million Danish kroner (65,58 million USD) in its Kalundborg plant in Denmark. The project will create 50 new production and engineering jobs in Kalundborg, where Novo Nordisk currently employs more than 2,400 people. Other ongoing investment projects at Novo Nordisk in Denmark include a new domicile in Bagsværd and a new facility in Kalundborg for the production of biopharmaceuticals such as haemophilia medicine and growth hormone. The investments in these projects amount to 2 billion kroner (350 million USD) (mediconvalley 2013).
outside through the ambassador program'. Another key task is the synchronization of plans within the cluster as ‘it is so difficult to have all the different stakeholders, having the same agenda at the same time’.

In terms of strategic planning and maintaining the attractiveness of the cluster, MVA points out the following four things: First, they are targeting complex issues with an interdisciplinary approach. Thus, using the fact that there are various universities involved that offer a wide range of research, which can be combined through networking activities. Second, similar to the first point, MVA tries to converge or ‘bridge’ different technologies for new innovative products by matching firms with other firms or researchers and companies. The third activity with which MVA aims to gain a competitive advantage is ‘clever networking’ locally and globally.

Part of our strategy is what we call clever networking – using the entire world as our partner. Instead of concentrating on the individual things, we try to built alliances collaborations all over the world, that’s why we have these ambassador programs...but also here in the region to try to create synergies between the different stakeholders by doing networking activities. (MVA interviewee, July 2012)

The fourth activity is what MVA calls ‘smart specialization’, where the focus is on specific areas in which the cluster has an advantage.

Beyond the outlined MVA activities, the direct involvement of government is an important aspect in the Medicon Valley cluster as it is wider spread than other examples and not only includes two federal governments on the Danish and Swedish side, but also regional and local governments as well as the European level. This multi-level context shaped the development of the cluster in various ways, as the section below highlights.

5.1.1. Multi-level governance setting

Many obstacles and boosts of cluster competitiveness originate directly or indirectly from national policies. In the Oresund Region, ‘1) national immigration and tax policy made Copenhagen less attractive to highly skilled foreign labour; 2) housing legislation has made it difficult to solve issues of housing affordability; 3) particular differences in national legislation of Sweden and Denmark have hindered the functional integration of the Øresund Region’ (OECD 2009a, 30). National government changes
also affected regional initiatives of clustering due to a governmental reform in Denmark. Since the mid-1980s, local and regional governments have become more active in the economic development of Denmark.

The net result was a conspicuous increase in the level of sub-national initiatives and from the early 1990s all regional and the majority of local government were engaged in activities aiming to stimulate indigenous economic activity, promote employment within their area, and secure a higher level of taxable income. (Halkier 2001, 332)

Once the regional level established itself as a major player in spatial economic policy, government aimed for a higher degree of coordination amongst actors on the sub-national level through permanent forums and joint Regional Development Plans, while the number of relevant actors grew significantly.

For the Øresund Region specifically, an ‘open house strategy’ was pursued, this means that multiple scales and different levels of institutions came together to form a particular place (Tangkjær 2000; Jensen & Richardson 2004). In fact, ‘the authority structure in the Øresund Region can be perceived as a black hole which has exercised its gravity on all kinds of political organizations and made various actors and agents rush in to fill it’ (Jensen & Richardson 2004, 153; Berg 2000). In light of these developments, the Danish local government reform (2007) addressed the power relationship between different levels of government – from supranational bodies like the EU to the local level. The effect of this reform was that 1) two national centres of growth appeared – the larger provincial towns of Eastern Jutland and the metropolitan region of Copenhagen; 2) the reform reduced Copenhagen’s room for manoeuvre. Thus a good deal of influence remained in the hands of the central government by rescaling the national state through giving a larger number of administrative obligations to the city, but at the same time dismantling parts of the city’s strategic capacity and institutions (Anderson 2008).

Still, after talking to representatives from the Capital Region of Denmark, they see themselves in a pivotal role of organizing and planning the clustering process and are also viewed as a key player by other stakeholders. While the European and national
level give money to local initiatives, for example INTERREG IVC\textsuperscript{31}, which helped establish the Øresund cross-border initiative, a lot of the programs launched at the national level have regional roots and are therefore informed by regional ideas. Further, the Capital Region of Denmark, as one of the five regions in Denmark, sees its responsibility in developing a strategy and identifying bottlenecks in the cluster. Together with the Growth Forum, a regionally located organization for 20 members appointed by the Regional Council and with a seat in the general Danish Growth Council, the region created a business development strategy with six focus areas – one of them being biotechnology. The Capital Region representative framed the work in terms of developing a strong regional strategy to attract foreign talent to the region and also looking into the living conditions of foreign researchers coming in, such as housing or international schools.

The Capital Region leads or cooperates with the following initiatives targeted towards cluster development:

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<th>Initiatives/Organizations</th>
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<td>Biologue</td>
<td>Innovation network that has endeavored for some years to strengthen the research collaboration between universities, hospitals and companies.</td>
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<tr>
<td>BioPeople</td>
<td>BioPeople is part of the permanent Danish infrastructure for innovation established and co-funded by the Danish Agency for Science, Technology and Innovation (BioPeople 2012)</td>
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<td>Interviewee comment: ‘they are closer connected to the universities in the region, located at Copenhagen University for large research projects. BioPeople is actually a national initiative, but has strong roots in the region, because before it was named ‘BioLuck’ and a Copenhagen thing, but now it is national and funded by government.’</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>COBIS is located centrally in Copenhagen near the research</td>
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\textsuperscript{31} INTERREG IVC provides funding for interregional cooperation across Europe. It is implemented under the European Community’s territorial co-operation objective and financed through the European Regional Development Fund (ERDF). The Operational Programme was approved in September 2007 and the period for INTERREG IVC will last from 2007-2013. The areas of support are innovation and the knowledge economy, environment and risk prevention. Thus, the programme aims to contribute to the economic modernisation and competitiveness of Europe.
| BioScience Park (COBIS) | institutions in biotechnology, medicine, and pharmacology.  
• Interviewee comment: ‘The program started in the Copenhagen region, funded by the region, but now it is a national program because the other regions also wanted to be part of it.’ |
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<td>Copenhagen Capacity</td>
<td>Copenhagen Capacity is the Danish Capital Region’s official inward investment agency. The mission is to promote the region internationally with the aim of attracting and maintaining foreign companies. Services are open to all foreign-owned companies and are free of charge. The services include business information, access to an extensive network of consultants, authorities and businesses. (Copenhagen Capacity 2012)</td>
</tr>
<tr>
<td>Copenhagen Innovation and Entrepreneurship Lab (CIEL)</td>
<td>• CIEL is a new platform for collaboration between universities and the industry. It represents an alliance between three major universities in Copenhagen and embodies their joint efforts to develop and support initiatives within innovation and entrepreneurship for the benefit of students, industry, research and education within the region. (CIEL Lab 2012)</td>
</tr>
</tbody>
</table>
| Copenhagen Spin-outs (at Copenhagen University) | • Copenhagen Spin-outs is an EU and Copenhagen Region-funded organization that works in collaboration with industry to aid in the commercialization of research results for the development of more spin-outs from academic research institutions.  
• Interviewee comment: ‘They have appointed scouts at the institutions and also they have some training opportunities for researchers to be more innovative and in commercialized thinking.’ |
| Copenhagen Talent Bridge | • Initiated and funded by ‘Copenhagen Capacity’, the Talent Bridge was established in 2011 and aims to attract more international talent in the shape of specialists and international students to companies and educational establishments in Denmark. (Copenhagen Capacity 2012) |
| Danish Association of the Pharmaceutical Industry (Lif) | • Lif’s mission is to ensure that the pharmaceutical industry has the best possible conditions to research, develop, market, distribute and provide information on medicinal products. The membership consists of companies that either have Danish head quarters, are subsidiaries of international companies, companies that are along doing research or companies that are both into sale and research. (Lif DK 2012) |
| Danish Biotech (Dansk Biotek) | • Dansk Biotek is committed to leverage the Danish biotech industry on a national and international basis. Part of the work involves raising the awareness nationally about the conditions for the biotech industry, which we do through the media and through correspondence to national governmental representatives. (Dansk Biotek 2012) |
| Growth Forum | • Regional Growth Forums are established in all five Danish Regions (Northern Jutland, Central Jutland, Southern Denmark, Zealand, Capital Region) and additionally one Growth Forum in the regional community of Bornholm. Each Growth Forum consists of 20 members appointed by the Regional Council. On the national level, the Danish |
Growth Council ensures cohesion between the regional efforts and the government business development policy. The chairman of each Regional Growth Forum has a seat on the Danish Growth Council. The forums act as a stimulus for regional innovation by advising Regional Councils on regional business development and innovation support measures and subsidies.

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Invest in Skåne</strong></td>
<td>• Invest is the official regional promotion agency facilitating inward investment to Sweden’s southernmost region Skåne, as well as promoting internationalization of the regional industry. The organization provides free professional advice and services to companies considering Skåne for future investment and/ or expansion and also assists Swedish companies to find international partners.</td>
</tr>
<tr>
<td><strong>Medicon Valley Alliance</strong></td>
<td>• As a non-profit member organisation, Medicon Valley Alliance carries out initiatives on behalf of the life science community in Medicon Valley. Medicon Valley Alliance is committed to facilitate economic growth, increased competitiveness, and employment in Medicon Valley, and is furthermore committed to raise the international recognition of Medicon Valley with the aim of attracting labour, investments, and partners. (MVA 2012)</td>
</tr>
</tbody>
</table>
| **Øresund Science Region (ØSR)**   | • ØSR is a cross-border imitative that brings together regional authorities, businesses and universities. This so-called triple-helix model is a focused approach to cooperation between universities and the surrounding society. The bottom-up initiative started in 2002 and is a regional development project with innovation and research platforms and projects as tools. The pillars of ØSR are the five platforms within the sectors of logistics, IT, food services, environmental science and life science.  
  
  • Interviewee comment: ‘it was the platform for the research collaboration, the universities in the Øresund Region were represented here and had a lot of cooperation. Right now they are restructuring this organization and we don’t know how it will be in the future’. |
| **Wonderful Copenhagen**            | • Wonderful Copenhagen markets the City as an attractive tourist destination, an international event location and a green and efficient congress and cruise destination. |

**Table 8 Initiatives and organizations aiming to enhance competitiveness in the Øresund Region.**

The variety of partners and initiatives connecting and supporting stakeholders at different government levels and also within the cluster reveal several different aspects about the set-up and the role of the regional government in cluster development. First, the Capital Region is aiming for a more city-focused network based on growth strategies (Jensen & Richardson 2004). This is visible in all the initiatives targeting Copenhagen,
such as ‘Wonderful Copenhagen’, ‘Copenhagen Capacity’, the ‘Copenhagen Talent Bridge’ or the ‘Øresund Science Region’. Second, the Capital Region is clearly trying to differentiate itself from other regions in Denmark, but also in Europe (Andersen 2008). The bridge to Sweden and the combined research in life sciences has made this easier. The advertising and the branding of the Øresund Region by the national government and the idea of Medicon Valley helped to put the region on the map for life sciences within Europe and beyond. Third, the number of projects and forums listed above show that there is currently no need for more institutions. In fact, the 2009 OECD report on territorial reviews states that rather than create more institutions, networks should be stimulated in the region. Overall, it becomes clear that the key issue right now would be to work on inter-organizational and inter-governmental competences.

From a cluster perspective the national level government can contribute largely to framework conditions on skilled labour, the strategic vision, branding and the overall elimination of bottlenecks. Creating a larger talent pool in the region mostly benefits from the following initiatives:

- Tax reductions,
- immigration policy,
- housing legislation,
- the university system, and
- advertising the region.

In this multi-level setting, the Medicon Valley Alliance (MVA) is ‘on the ground’, connected to researchers, firms and also to government officials. It is the most important player for the Øresund Region to facilitate networking and partnerships (IRIS 2009). By supporting the networking activities as one cornerstone of the cluster development factors, it connects the multiple levels and facilitates the collaborative and absorptive capacities of the cluster.

5.1.2. Collaborative and absorptive capacities

The collaborative and absorptive capacity frameworks enable the identification of activities that enhance growth and productivity within a cluster. They are used to break down cluster capabilities into observable units such as agreements, policy guidelines,
virtual platforms etc, which can then be analyzed separately and conjointly in terms of their efficiency and effectiveness.

**Collaborative Capacity**

Collaborative capacity entails purpose, communication, structure, and resources. All these elements are crucial for a network or cluster to connect multiple stakeholders (Lai 2011).

*Purpose* is defined as having leadership and a shared vision that focuses on collaborative efforts (Lai 2011). As mentioned before, one of the main challenges MVA is facing is the fact that different stakeholders have different agendas at different times. Thus the goal is to bring them all together in an informal networking structure in order to give the cluster direction and purpose. The alliance worked, since its establishment in 1997, towards a position that would enable it to define such a purpose. The fact that big pharmaceutical companies were already in the area and the life sciences research field was strong at Swedish and Danish universities, also helped to define the cluster’s direction. Once stakeholders saw MVA as a strategic leader and a membership community was established, the alliance was able to – according to one interviewee – ‘lobby with decision-makers and opinion-leaders of government, civil servants and so on and so forth – to get them to the right decision at any given time’. MVA also took on the role of branding the cluster. This is a longer process, but with the support from government funding and the newly branded Øresund Region, MVA was able to define Medicon Valley and its focus on pharmaceuticals. Just recently, MVA developed the beacon initiative, which emphasizes the strengths of the cluster compared to other life science networks for example in the field of drug delivery.

The beacon strategy document was developed in collaboration with the Copenhagen Business School and ‘numerous contributors from the Øresund Region’. It outlines the importance of life sciences for the global market in general and the Øresund Region in particular. For example, the fact that the demand for health services will be growing, both globally and locally, which makes it an interesting field to invest and research in. However, as the document points out, this industry will also become more competitive as the elderly market grows and attracts new entrants. Clusters will more fiercely compete around attracting talent as political regions see their older industries
decline, ‘they will invest more in the buoyant life sciences hoping to survive’ (MVA 2011). One way to approach this development is to identify so-called ‘beacons’, the region’s stronghold, and turning it into an attractor.

A beacon should reflect the needs of tomorrow’s life science environment and thus needs to be conscious of future trends and requirements...A beacon also is part of the regional identity and to be successful, a beacon most likely needs competences held by more than just a few organizations. (MVA 2011, 5)

However, the beacon is only successful if there is regional excellence in that specific area and global awareness of it by other stakeholders. This means that the excellence has to be advertised in order to attract venture capital and scientists from abroad, which is part of the success of Silicon Valley, San Diego or Boston. Medicon Valley is focusing on drug delivery as one beacon, which is the process of achieving a therapeutic effect of pharmaceuticals. In this increasing competition, the abilities of MVA to access global pipelines and to identify external knowledge and the competitive advantage of internal potential becomes even more important (Wolfe & Creutzberg 2003).

The beacon strategy, which responds to the growing need for identifying a network’s purpose, is communicated widely inside and outside the cluster. Those communication channels are crucial for a purposeful development. Communication in general and communication channels in particular ensure information transmission in a cluster and also put information in the context of solution-seeking (Lai 2011). This means that through information links, such as formal agreements or active communication, crucial information on the industry, the network, and also knowledge are exchanged.

In the Medicon Valley case, MVA was able to build a certain level of communication, which also led to higher levels of cooperation. Board meetings or regular meetings between stakeholders enable new connections and, on top of that, research talks inform industry about investment options at universities. Also, the amount of information shared among cluster members is bigger due to the fact that 1) they meet on a regular basis and 2) MVA functions as core node and service entity to distribute this information. New opportunities through communication also arise from MVA’s connection to government; something smaller firms might otherwise not have access to.
On the one hand, MVA is consulted by the regional government on strategic decisions and future funding of cluster initiatives and on the other hand MVA lobbies for the local life science industry at regional and national level on the Danish and Swedish side. For many stakeholders – especially industry and government – MVA is also the communication channel to other clusters through the ambassador program.

The ambassador program has become a structural component for the cluster to connect globally, as have the regular (board) meetings and meet-ups among stakeholders. The structure of a cluster describes formal or informal procedures of networking. This structure then ‘allows flexibility and adaptability for collaborators to remain open in the midst of major changes, such as transformations of major goals or members’ (Lai 2011, 451). A good example is again the beacon strategy. Through the structural set-up of regular meetings, different stakeholders were able to contribute to the strategy and decide on the beacons.

The financing structure of MVA also contributes to a close-knit network. Because all members pay a fee, everyone is committed to supporting MVA in their efforts and at the same time use their services. A interviewee from Denmark’s Technical University points out that there are practical advantages to be a member, such as getting contacts to commercial companies who would support the university’s science in a particular field – ‘so the services they provide, we actually use them’. However, a change in the Danish ‘Science Patent Law’ is posing an obstacles for universities to share knowledge. Denmark adopted the law in 2000, which lays out that intellectual property rights (IPR) are owned by the university. This increasing focus on rights and the law change led to a fear of contact ‘where scientists have become reluctant to exchange knowledge’ (IRIS 2009). On top of that, this change led to the fact that Denmark and Sweden now operate with two different patent laws. While in Denmark the university has the patent rights, in Sweden IPR remains property of the inventor (Telleman & Dimetz 2005). Thus such legal regimes not only hinder the cooperation between firms and universities within Denmark, but also the cross-border partnership in the Øresund Region. Overall, Medicon Valley is embedded in a wider structure of national and regional governments. From the regional government perspective, interviewees emphasized the ability in meetings to 1) consult MVA based on their experience of bottlenecks ‘out in the real world’ and possibly take that information further to the national government if needed.
and 2) connecting with all the stakeholders. Based on this, MVA knows about the patent law challenges and can address this issue with government, but ultimately the national regulatory system has to change. This highlights one of the limitations of facilitation, as even in a well-organized and connected cluster such as Medicon Valley, the manager’s hands are tied when it comes to national regulations.

The resources of the cluster and MVA, which include financial, intellectual and human capital, affect the ability of the network to function, cooperate and commercialize properly. From a financial standpoint, two issues have been emphasized by interviewees. First, the resources Medicon Valley has are by far not as much as the ones renowned clusters like Boston or Silicon Valley have, thus clever networking and differentiation from those bigger clusters is all the more important. Second, the big pharma companies, such as Novo Nordisk or Leo Pharma are owned by foundations, which secure funding in the sense that a hostile take-over is much less likely than for firms that are on the open stock market. The Novo Nordisk foundation (2013), for example, aims not only ‘to provide a stable basis for the commercial and research activities conducted within the Novo Group’, but also to contribute to scientific, humanitarian and social progress. This results in – according to one interviewee – donations of billions of Euros every year into research and initiatives such as the beacon strategy.

Another financial resource in the development of the cluster has been and will be the European Union. The Öresund Region was established with European funds and according to the Capital Region government there is new money coming in through regional programs in 2014. But not everyone in the cluster agrees that EU funding is convenient and beneficial. One interviewee from MVA calls it a ‘nightmare’ with ‘absolutely no value’, pointing out that most of the money is spent on bureaucracy in Brussels and consultants that are ‘remote from real life’. As such, the European funding may take some of the financial burden from the regional government, but adds on to the administrative work for MVA organizing such funds.

Human capital in the region, as another important resource, benefits from the link to the Swedish region of Skåne and the Capital Region of Denmark. The talent pool for firms on both sides of the border is big, as it includes universities such as DTU,
Copenhagen and Lund University and Danish/Swedish research institutes. Although Danish immigration and housing policy was not always in the cluster’s favour, the expert tax and the overall marketing of the region helped to attract talent. One facility that stood out during the interviews for its human capital generation and attraction was MAX-lab IV\textsuperscript{32}. It is located at Lund University and educates young researchers and also attracts a research community from all over the world.

To further attract talented researchers from all over the world, Denmark is offering an expert/scientist flat-rate on taxes since 1992. Due to the high amount of taxes citizens have to pay for a well-established social security system, government decided that experts or researchers for the first three years of employment, are only taxed at a rate of 25 percent instead of the regular income tax of 39 percent and up to 60 percent\textsuperscript{33}. That rate is levied on gross salary as reduced by ATP contributions\textsuperscript{34}, labour market contributions, special pension savings and obligatory foreign social contributions. When the three-year period covered by the 25 percent tax scheme ends, the employee may continue to stay and work in Denmark up to 48 months, but will then be taxed the regular rate (Ernst & Young 2008; Ministry of Foreign Affairs of Denmark 2013). This tax reduction, as one university interviewee pointed out, made the labour market in Denmark more attractive and prevented some PhDs from leaving after their studies. This means those trained researchers were available in the country’s talent pool for local firms. He goes on by emphasizing that this tax is one of the ‘basics’ a cluster is developed and built on.

Another tax-related issue is the problem of financing small- and medium-sized firms before venture capital moves in. One of the industry’s obstacles is that most

\textsuperscript{32} The MAX IV Laboratory was established July 1, 2010 as a national research infrastructure hosted by Lund University through an agreement between the Swedish Research Council, VINNOVA [innovation-support agency dependent on the Ministry of Enterprise, Energy and Communication], Lund University, and Region Skåne. The MAX IV Laboratory is the successor of the MAX-lab national laboratory and includes both the operation of the present MAX I, II, III facilities (MAX-lab) and the MAX IV project aiming at constructing the new MAX IV facility at Brunnskögen in the North Eastern part of Lund’ (MAX IV 2013).

\textsuperscript{33} Danish income tax rates are progressive 39 percent on income up to 22.118 Euro; 45 percent on income between 22.118 and 36.025 Euros and 60 percent on income above 36.025 Euros.

\textsuperscript{34} The Danish Labour Market Supplementary Pension.
biotech companies are not able to exploit tax deductions for R&D, because they have no income. Thus, the recommendation by OECD in a 2009 report was to introduce ‘a scheme which permits small and medium-sized companies (up to e.g. 250 employees) to have the R&D tax relief paid out immediately in fiscal years where the company generates the deficit’ (Ibid, 19). Also, the Danish Council for Science, Technology and Innovation has recently initiated a ‘proof of concept’ scheme, ‘which offers the possibility of a grant up to DKK 750,000 for the maturation of ideas based on research in hospitals and universities’ (Ibid, 20). But as the study shows, those funds are often too limited for the length of time biotech projects take.

Immigration policy also plays a role in enhancing the life science talent pool. Currently, Copenhagen’s share of immigration is below average compared to other metropolitan areas. Therefore, a ‘green card’ scheme and the mentioned tax arrangements for highly skilled foreigners have been adopted nationally, ‘but these policies do not constitute a sufficient incentive, by comparison to those of many other OECD countries’ (OECD 2009a, 20). The low levels of skilled people coming into Denmark and retaining qualified Danish graduates also affects the Øresund Region. Especially the Medicon Valley cluster is interested in government action for cross-border commuting between Denmark and Sweden through the provision of harmonized regulation, taxation, social security and tariffs to promote labour market integration in the area.

A reoccurring issue in the Copenhagen region has also been housing regulation. Not only high taxes, but also high housing costs are reasons for skilled workers not to move to or stay in Copenhagen. Most of the interviewees saw this as one of the reasons why people only stay for a short amount of time in the city and a lot of graduates leaving after finishing their university education. They see government in the position to provide affordable housing for researchers (and their families) that would like to stay in the city.

Retaining people after they graduate was another element linked to amount of human capital during the interviews. Students in the region are completely funded for a certain number of years when they pursue a degree at a Danish or Swedish university. The expectation from this would be that the public in general is highly educated and more people earning a university degree, but in reality this funding scheme has some
serious, negative effects for the industry. Because students are funded, they are more likely to change subjects throughout the course of their education and thus spend more years at university than any other country in Europe. Denmark also has high drop-out rates, which leads to the fact that – at least in the metropolitan area of Copenhagen – the population’s level of attainment in higher education is not as high as that of many US and Nordic cities, for example Boston, San Francisco, Stockholm or Helsinki. Also, due to generous grants, students have a late entry into the labour market, leaving fewer years to practice their acquired skills in the work force (OECD 2009a).

Absorptive capacity

The absorptive capacity of the cluster highlights the ability ‘to integrate the existing and exploitable resources – technological opportunities – into the production chain and the foresight to anticipate potential and relevant technological trajectories’ (Narula 2004, 6). Further, absorptive capacity describes the ability to react to change, such as the financial crisis, and connect to knowledge sources inside and outside the cluster (Giuliani 2005). Fostering this capacity requires an understanding of:

(1) the cross-scale relationships, interconnections, and networks among formal institutions and organizations that provide context for social processes of renewal and transformation; (2) existing and evolving power relationships among different groups with scale-specific (a community-based organization) or multi-scale responsibilities (a government agency); (3) the informal and often more intangible, socio-political relationships of trust and influence that shape collaboration and learning; (4) control over knowledge and the valuation of different types of knowledge by different social actors; and (5) the degree to which evolving cultural norms and values remain consistent with collective action and collaborative learning. (Armitage 2008, 69)

In sum, to develop this capacity, the interaction between levels is crucial. This includes multi-level governance arrangements as well as formal and informal relationships within the network. This also undermines the context-driven development of the cluster as framework conditions can hinder adaptive capacity, which then lead to the challenge that the cluster might not be capable of integrating policy change. Thus the more crucial it becomes to have a cluster organization that drives those capabilities from the inside.
For tapping into inner and outside knowledge sources for example, MVA is updating firms about research developments and research about contract opportunities (‘match-making’), while at the same time having ambassadors in other clusters to learn about best practice and new developments. By doing this, MVA becomes not only valuable for the cluster itself, but also for government. Based on this generated information, stakeholders can learn and link up to these sources without having to find them on their own.

The Ambassador program turned out to be a major learning experience for MVA and has been expanded since its launch in 2008. Through the people that are sent out to other clusters around the world, MVA gains insight into management practices and programs in other countries. The program also has its own funding pool, which is separate from MVA. From 2009 to 2012 the MVA Ambassador Program has been financed by the three regional organizations in Medicon Valley; the Capital Region of Denmark, Region Skåne and Region of Zealand. Starting this year and up until 2017, the program will be supported by the Capital Region of Denmark and Region Skåne. On top of that, ambassadors acquire self-financing based on grants. For example, Thomas Jonsson has been positioned in Japan since 2008 and is now up to 70% self-financed. Torsten Jepsen is entering his second year in Boston and has already obtained 40% of own funding sources (MVA 2013). The goal is to establish lasting relationships with the regions that are part of the program beyond the time the ambassador is located there and have an ongoing learning experience.

Overall the levels of collaboration and absorptive capacity for Medicon Valley are high, as displayed in Table 9.

<table>
<thead>
<tr>
<th>Collaborative Capacity Framework</th>
<th>Basic elements</th>
<th>Collaborative activities</th>
<th>Yes</th>
<th>In Progress</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Leadership</td>
<td>Identification of leadership role</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared Vision</td>
<td>Mission statement/agreement</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network membership</td>
<td>Connection to a broader functional network</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td>Formal and Informal Procedures</td>
<td>Memorandum/interagency planning document</td>
<td>x</td>
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<tr>
<td>Clear Roles</td>
<td>Agreed and informed policy guidelines</td>
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<td></td>
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<tr>
<td>Communication</td>
<td>Information Links</td>
<td>Formal agreements/ personal connections</td>
<td>x</td>
<td></td>
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<td></td>
<td>Active Communication</td>
<td>Communication technology, e.g. boundary-free information platform</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td>Knowledge and Skills</td>
<td>Knowledge-based modes using techniques such as pre-planning, role plays, on-job training, drills and exercises, and simulation for collaborating managers</td>
<td>x</td>
<td></td>
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<tr>
<td>Financing Powers</td>
<td>Collective financial pool</td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>Absorptive Capacity Framework</th>
<th>Basic elements</th>
<th>Absorptive activities</th>
<th>Yes</th>
<th>In Progress</th>
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<tbody>
<tr>
<td>Intra-cluster knowledge system</td>
<td>Knowledge spillovers</td>
<td>Stakeholders links</td>
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<td></td>
<td>Social relations</td>
<td>Collective learning processes</td>
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<tr>
<td>Extra-cluster knowledge system</td>
<td>Extra-cluster knowledge sources</td>
<td>Linkages to those sources</td>
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<td></td>
<td>Interface between the external linkages and the intra-cluster knowledge system</td>
<td>Acquiring new knowledge from extra-cluster sources and transferring knowledge to intra-cluster firms</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 9 Medicon Valley’s collaborative and absorptive capacity.*
5.1.3. **Concluding remarks**

The example of Medicon Valley shows how dependent clusters are on favourable framework conditions created by all levels of government – from the European to the regional level. However, the importance of regional empowerment and increasing impact of regional initiatives and the cluster organization were also highlighted (Gualini 2004). This became apparent in the uptake of regional projects at the national level and the consultation of local stakeholders, such as MVA on innovation bottlenecks for national policy. Based on this, the role of MVA can be described as crosscutting the multiple levels, facilitating connections among them as well as integrating ‘local buzz’ and ‘global pipelines’ (Wolfe & Creutzberg 2003).

While the cluster organization takes a central role in the network, it also links up actively to regional players and informs the national level. MVA is directly linked to the EU through financial support and European regional cooperation projects in which it participates. With global competition heating up, tapping into knowledge sources locally and globally has become another key to creating innovative processes. The ‘local buzz’ derives from the closeness in the cluster – face-to-face meetings, as well as formal and informal networking events. MVA channels some of this buzz by giving stakeholders a forum and actively connecting researchers and businesses. Important knowledge is also acquired through pipelines to other clusters around the world. MVA has addressed this by setting up the ambassador program. This program is gaining momentum for the region’s life science organizations, as collaboration agreements have been established between universities and SMEs have been helped in making the first step into the international arena. ‘The ability of firms to access such global pipelines and to identify both the location of external knowledge and its potential value depends very much on the internal organization of the firm, in other words, its ‘absorptive capacity’’ (Wolfe & Creutzberg 2003, 24). Thus, capacity-enhancing activities help cluster stakeholders to use the knowledge and connections they get more efficiently and ultimately perform better.

**Facilitator model**

The cluster facilitation model the Medicon Valley example represents is one where government and stakeholders are both invested into the institution and therefore
expect certain benefits and services. MVA is funded by the three regions that belong to the Øresund partnership – Capital Region of Denmark, Region Zealand and on the Swedish side, Skåne – the universities, such as the Technical University of Denmark (DTU), Copenhagen and Lund University and most of the (small) biotech companies. This money accounts for about 50 percent of the MVA budget, while sponsorships and EU funding make up the other half. Based on this procedure MVA was able to gain trust early on by having EU funding and government support. Now, once they have stakeholders on board, the government plans to slowly diminish its contribution in order to show that the model is sustainable solely based on stakeholder support. The stakeholders, on the other hand, value the work MVA is doing based on the fact that the institution is plugged into the multi-level governance system and able to lobby for the life science industry. MVA delivers services such as networking events, marketing the cluster to international and national investors and develops long-term visions for the network, as currently underway with the beacon strategy. The facilitator also prides itself with its learning model by having ambassadors go out into other successful clusters to bring back best practice models that could possibly be applicable to the Øresund region. However, working with stakeholder funds also makes the facilitator more vulnerable to acting in favour of a dominant group in the network as their expectations are linked to the money they invest. This could affect the level of trust by other stakeholders and even government. Ultimately, MVA has to walk a thin line of pleasing all stakeholders, providing opportunities to all groups for the cluster to thrive and staying closely connected to government, even though the funding relationship is being phased out.

5.2. Chicago (Illinois, USA)

Illinois or rather the larger Chicago area is developing into a successful life science cluster integrated into a larger network of biotech collaborations in the Midwest. The so-called ‘Midwest Super Cluster’ consists of nine clusters in the states of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio and Wisconsin. Collectively they face stiff competition from the Coast – in the West from the Bay Area in California and in the East from the life science cluster in Boston. Thus, they are aiming to use their combined force to brand the region for biotechnology development in order to attract human and venture capital. Today, the nine-state cluster employs more than 377,900
people in approximately 16,800 establishments. It is advertised as being ‘the most balanced of the biotechnology regions in the United States’, because it covers a variety of areas, such as agricultural feedstock and chemicals, bioscience-related distribution, drugs and pharmaceuticals, medical-device equipment as well as research, testing and medical laboratories (Illinois Biotech Industry Organization 2013).

Illinois in particular hosts the largest concentration of biopharma companies and is a ‘strong driver of the industry’s vitality and growth’ in the region (Illinois Biotech Industry Organization 2013). Within the 400 miles of Chicago alone, there are more than 15,500 biotechnology establishments employing around 360,000 people. This is related to several factors. Vital for the establishment of this network is the location of several multinationals in the Chicago area, such as Abbott, Baxter, Takeda, Astelles, Valent BioSciences, Tale & Lyl and Hospira & Lundbeck (Illinois Innovation Network 2013). For the research component and possible spin-offs, Chicago houses several high-ranking universities and research institutions, including Northwestern University, University of Illinois, Illinois Institute of Technology and the University of Chicago – all of which have dedicated Biotech programs. Beyond those 173 pharmaceutical and biotechnology companies, which are also the basis for clinical trials and clinical affiliations with hospitals and medical practices, Illinois has federal labs and federally funded research in place, for example, the Argonne National Laboratory or the Fermi National Accelerator Laboratory (Lin 2008). Historically, Illinois had a breakthrough in the biotechnology field in the 1980s when it supported what many consider to be the number one biotech company, Applied Molecular Genetics, now known as Amgen. The company’s creation was based on technology out of the University of Chicago and capital and management from Abbott labs35 (Rosen 2009).

Overall, Illinois’ 173 pharmaceutical and biotechnology companies are a far cry from California’s total of 1,439 and many companies as well as researchers or entrepreneurs are still drawn towards coastal states like Massachusetts, New Jersey and Pennsylvania (Lin 2008). Therefore, supporting the collaborative and absorptive

35 The late Eugene Goldwasser developed ‘EPO’ out of the University of Chicago; however, he was unsuccessful in persuading the university in patenting the discovery, which led to the company affiliation and the move to the coast. He later became a consultant for Amgen, which became successful with the drug (Easton 2010).
capacities of the cluster is important to retain talent and attract investors and new companies. According to the interviewees, the cluster grows its capacity by having a dedicated government department, the ‘Office of Entrepreneurship, Innovation and Technology’ and the cluster organization Illinois Biotechnology Industry Organization (iBIO) as main organizers of the network.

The Office of Entrepreneurship, Innovation and Technology belongs to the Illinois Department of Commerce & Economic Opportunity and was established with the help of a biotech entrepreneur with many years of experience. He shaped the office according to the needs of the cluster and in line with what the Commerce Department was able to offer. Currently, the office has the ability to invest directly into some companies, without taking the lead and up to a certain amount while also offering assistance in a variety of areas, such as business planning, marketing & product development, training, business assessment, counseling and networking as well as contracting and international trade.

The primary goal of government is to provide so-called ‘gap funding’ for smaller businesses. Those are state-sponsored programs that bridge the perceived gap in venture funding. These target the start-up biotechnology community, which might have difficulties in attracting funding. Some of these programs include tax credits for firms that make an investment in one of the state’s qualified new business ventures or the state-owned venture fund called ‘Invest Illinois Venture Fund’ (2011), which aims to accelerate investments for small innovative companies (Illinois Biotech Industry Organization 2013). Specific programs launched by the office include:

- Establishment of Small Business Development Centres (SBDC) for one-on-one counseling for new and existing small businesses
- Creation of Procurement Technical Assistance Centres (PTAC) for companies interested in selling products to government agencies
- Offer of counseling and training for companies interested in international trade and exporting in International Trade Centres (ITC)
- Manufacturing Extension Centres (MEC) for the according manufacturing companies to improve performance.

And finally, setting up the Small Business Environmental Assistance Program (SBEAP) to help businesses, which have to comply with state and federal air pollution regulations. Overall, the office helps to service smaller companies in their quest to
become part of the Illinois life science community and at the same time comply with state rules and find possible funding opportunities.

Recently, the establishment of a University of Illinois (UIC) Health Technology Research Hub for the bioscience industry made headlines. It is financed by a $1.7 million state capital investment, which was matched by $1.7 million of UIC funds. The facility will host lab and office space with the goal of bringing together scientists, clinicians, engineers and industry (Illinois Innovation Council 2013). This is something that was greatly encouraged by entrepreneurs and researchers in Chicago. Most interviewees emphasized that having access to often expensive equipment after leaving the university environment is not only crucial for further developing a product, but also enables network relationships with other disciplines and larger industry stakeholders. These connections might then lead to further networking or even investments.

These efforts go hand-in-hand with the work that the Illinois Biotech Industry Organization (iBIO) is doing. iBIO is a life science industry association composed of international as well as small- and medium-sized companies in the agricultural and human health sector, entrepreneurial leaders of start-ups and spin-offs, scientists and technology transfer specialists, venture capitalists, seasoned government people, service providers from major law, accounting financial and research firms as well as a variety of business professionals. Apart from industry leadership, there is also public policy input through the 'iBIO government affairs committee' on human health and food and agriculture. Committee members meet with various government officials and their staff to gain information, offer insight and advice. The merger of two organizations led to the formation of iBIO. One was called the Chicago Biotech Network (CBN) association, land organization, and the ‘old’ iBIO, which defined itself as a crop association focused on downstate agriculture.

Today, iBIO has two target areas: agriculture and pharmaceuticals in the biotech field and is currently looking into a third area related to medical devices. Including the device industry into the Illinois network is interesting for the region, due to the sector’s
growth in recent years\textsuperscript{36}. Another indication of iBIO’s expanding activity is its ability to initiate advocacy downstate with the Illinois legislature to promote an environment attractive to firms and research. This is no small mandate as Illinois lags behind in venture and angel capital, the major fuel for start-ups (Rosen 2009). Its mission, as iBIO puts it, is to:

make Illinois and the surrounding Midwest one of the world’s top life science centres by promoting sound public policy at the local, state and federal levels, improving Illinois’ and the Midwest’s ability to create, attract and retain businesses, and through the iBIO institute, deliver education, training for students, biotech professionals and the general public. (iBIO 2013)

iBIO also has a program specifically addressing early-stage life science companies in Illinois. The PROPEL centre for example, established in 2007, is a group of programs aimed at increasing the number and success rate of start-ups and helps guide the development of formation-stage and early-stage life science companies by providing entrepreneurs with access to specialized resources and expertise (PROPEL 2013).

Another platform for collaboration is the Illinois Science & Technology Coalition, which provides networking opportunities in different kinds of technology areas – including life sciences. Due to its broader focus, it mostly connects Illinois to outside stakeholders, as this recent report indicates:

In May [2012], the ISTC and partner iBIO signed an MOU with the Shanghai Biopharmaceutics Industry Association (SBIA). The MOU established a relationship with the SBIA that will increase investment and innovation in pharmaceuticals, economic development, medical devices, and related sectors. Targeting International Collaboration The ISTC also signed an MOU with BIO-RIO (Pólo de Biotecnologia do Rio de Janeiro) in September as part of Governor Quinn’s trade mission to Brazil. (ISTC 2012, 6)

\textsuperscript{36} The medical device field employs about one in five workers in the life science industry and even during the recession, the sector was able to have a job growth of 2.6 percent over the 2008-2010 period (BIO 2010).
5.2.1.  **Collaborative and absorptive capacity**

**Collaborative capacity**

Talking to people in the cluster, there is a shared *vision* and strategy in place connected to the two leading organizations – the Office of Entrepreneurship, Innovation and Technology and iBIO. The most recent commitment to the goal of having Chicago and the greater Illinois area as the ‘biobasket’ of the Midwest, is the attraction and support of the BIO convention. During a planning meeting for this event, which I was able to attend, it became clear that the two objectives were (1) to showcase the region to international and national companies and investors and (2) to make the convention accessible for everyone in the network. To realize the second goal, the Biotech Industry Organization offered 25 grants for smaller companies to cover the fees of attendance. Organizers also set up special events for entrepreneurs, for example meet-up opportunities with bigger companies as well as an entrepreneur ‘boot camp’. There were also special attendance fee offers for academic researchers and young companies. The event drew over 16,000 attendees from industry, government and academia from 62 countries. To organize an event of this scale, iBIO can tap into the network of its parent organization, Biotechnology Industry Organization (BIO). ‘BIO represents more than 1,100 biotechnology companies, academic institutions, state biotechnology centres and related organizations across the United States and in more than 30 other nations’ (BIO 2013). Members are involved in different areas, such as healthcare, agriculture, industrial and environmental biotech. Beyond the BIO convention in Chicago, the organization also hosts other events, such as a biotech conferences in China, Montreal or Washington, DC.

There is no formal strategy guiding Illinois or the City of Chicago in relation to biotech, however, the political commitment is visible. Most interviewees emphasized the engagement and support by Governor Quinn. He created the Illinois Innovation Council to promote and attract innovation-driven entrepreneurs to the state. For his work increasing Illinois’ economic, scientific, and technological output, Quinn was named the 2011 Governor of the Year by the Biotechnology Industry Organization. They also

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37 Pat Quinn (Democrat) was sworn in as the 41st Governor of Illinois on Jan. 29, 2009. He won election to a full term on Nov. 2, 2010.
pointed out that he has – as an addition to the Innovation Council – a group of people from industry and academia, including CEOs from big companies, entrepreneurs and researchers that inform him about current developments in the field. As later sections will show, this commitment also shines through in the way federal research money is spent. The most important goal and also measure of success seems to be the number of jobs created and the overall growth in the state. According to stakeholders, the current state government is the third one in a row to consistently support biotechnology in Illinois. This engagement has been a catalyst for increased National Institute of Health (NIH) and Food and Drug Administration (FDA) funding. The consistency is something network members watch closely due to the fact that some are afraid the biotech trend is just a short-term hype, which will die off eventually. Thus, they are hoping for a sustainable long-term development with continued funding opportunities.

One of those long-term commitments was the change in the mission statement of one of the major academic players in the network, the University of Illinois, by adding ‘economic development’ to the institution’s mission. The statement reads ‘The University of Illinois is among the preeminent public universities of the nation and strives constantly to sustain and enhance its quality in teaching, research, public service and economic development’. The ‘economic development’ component implies, according to university officials, that they are focusing more on the technology management or technology transfer offices in creating procedures for the university to be aware how to commercialize their intellectual property and generally have closer ties to industry. Enabling researchers to create spin-off companies and gain investment from industry creates jobs and contributes to the economic development of Illinois. These changes are part of a growing movement towards commercialization in the region. For achieving this goal, stakeholders point towards iBIO itself or the programs it is involved in, such as PROPEL or the Innovation mentors (for a list of institutions and programs key to the Chicago cluster, see Table 10). Also, due to the fact that the people driving these engagements are a small group of experts, network members know who to turn to. This core group also exchanges ideas and developments on a regular basis.
<table>
<thead>
<tr>
<th>Organizations/Programs</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Invest Illinois Venture Fund (IIVF)</td>
<td>The Invest Illinois Venture Fund (IIVF) is a venture capital program seeking to support young, innovative companies, and start-ups that show a high potential for future growth resulting in the creation of high-paying professional Illinois jobs. $78 million from the federal State Small Business Credit Initiative (SSBCI) of the Small Business Jobs Act of 2010 – used for the venture fund to support start-up companies and entrepreneurs. (Illinois Department of Commerce and Economic Development 2013)</td>
</tr>
<tr>
<td>Illinois Science and Technology Park (Skokie, ISTP)</td>
<td>Illinois Science + Technology Park has repurposed the former corporate headquarters of pharmaceutical giant G.D. Searle in Skokie, Illinois into a home for a community of scientists, researchers, inventors, and innovators. The facility boasts convenient access to Northwestern University and the Midwest's technology and life science business environment. The 23-acre master plan calls for up to 2 millions square feet of space. Key tenants include Astellas, Astellas Research Institute, Fresenius Kabi, Polyera, Auraseense, Carefusion, Akorn. (ISTP 2013)</td>
</tr>
<tr>
<td>University Technology Park at IIT</td>
<td>University Technology Park at IIT (UTP), located on the main campus of Illinois Institute of Technology offers flexible lab and office space for lease for both start-up and established technology companies in a supportive environment. The park is ten minutes south of Downtown Chicago with access to both airports. It is a four-building complex, which houses a custom-build-to suit TechnologyBusiness Center (TBC), a state-of-the-art Incubator, a 19-story office tower, and IIT Research Institute, one of the nation’s leading contract research organizations. (University Technology Park 2011)</td>
</tr>
<tr>
<td>IllinoisVENTURES</td>
<td>IllinoisVENTURES is a premier seed and early-stage technology investment firm focused on research-derived companies in information technologies, physical sciences, life sciences and clean technology. The company starts and builds globally-competitive businesses based on work conducted at Midwest Universities and federal laboratories. They bring together leading researchers and entrepreneurs to mold concepts, vision, intellectual property, sweat and passion into breakthrough, high-growth companies. Conceived and launched by the University of Illinois, IllinoisVENTURES has been consistently named by Entrepreneur magazine to its national list of the top 100 venture capital firms. (IllinoisVENTURES 2013)</td>
</tr>
<tr>
<td>Illinois Science and Technology Coalition (ISCT)</td>
<td>As the State of Illinois’ statutory recognized technology advisor and economic development partner, the ISTC serves a unique role in connecting the state’s universities and federal labs with industry and government, to leverage our world class assets for maximum economic impact. Located in 1871 - a hub of entrepreneurial and technological activity in</td>
</tr>
</tbody>
</table>
Chicago – the ISTC develops and implements initiatives which advance Illinois’ innovation capacity across sectors, and position Illinois as a national and global innovation leader. (ISCT 2013)

| Illinois Biotechnology Industry Organization (iBIO) | • iBIO’s mission is to make Illinois and the surrounding Midwest one of the world’s top life sciences centers: a great place to do business, and a great place to grow new technology ventures.  
  • With active support from corporate, academic and government leaders, iBIO:  
    o promotes sound public policy at the local, state, and federal levels;  
    o improves Illinois’ and the Midwest’s ability to create, attract, and retain businesses; and  
    o through the iBIO Institute, delivers education and training for students at all levels, biotech professionals, and the general public  
  • iBIO pursues this mission and work plan by promoting effective collaboration within and between the public, private, and academic/research sectors of our community. (iBIO 2013) |
| 1871/ project 71 | • 1871 is located on the 12th floor of the historic Merchandise Mart in Chicago and opened for business on May 2, 2012. It is an incubator, where venture capital, universities and start-ups are all working together – currently mainly in the digital sector, however recently life science entrepreneurs have started to move in. |
| Illinois Medical District | • The Illinois Medical District (‘District’) includes 560 acres of medical research facilities, labs, biotech business incubator, raw development area, universities, and more than 40 healthcare related facilities.  
  • The Illinois Medical District Commission (IMDC) is a seven-member body charged with operating, assembling and redeveloping land to enhance the District. Members are appointed by the Governor, Cook County President and Mayor of Chicago. Created by an act of the Illinois State Legislature in 1941, the Illinois Medical District (IMD) is the largest urban healthcare, educational, research and technology district in the nation. (IMDC 2013) |
| Governor’s innovation council/ Illinois Innovation Network | • The Illinois Innovation Network was established by Governor Pat Quinn in 2011 as a common platform to connect start-ups, innovation-driven enterprises, service providers, research and academic institutions, and community leaders to position Illinois as one of the world’s top innovation centers. (Illinois Innovation Council 2013) |
| Center for Clinical and Translational Sciences (UIC-CCTS) | • The Center for Clinical and Translational Sciences (UIC-CCTS) at the University of Illinois at Chicago was established in 2008 to provide an ‘integrated home’ dedicated to improving clinical and translational research at UIC by coordinating resources and services that facilitate health research and advance knowledge across the translational spectrum.  
  • The goal of the UIC-CCTS is to accelerate the translation of scientific... |
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<tr>
<th>Institution/Program</th>
<th>Description</th>
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<tr>
<td>Illinois Department of Commerce and Economic Opportunity (DCEO)</td>
<td>DCEO’s mission is to raise Illinois' profile as a global business destination and nexus of innovation; and to provide a foundation for the economic prosperity of all Illinoisans, through coordination of business recruitment and retention, provision of essential capital to small businesses, investment in infrastructure and job training for a 21st century economy, and administration of state and federal grant programs. (DCEO 2013)</td>
</tr>
<tr>
<td>World Business Chicago (WBC)</td>
<td>WBC is a not-for-profit economic development organization, which leads Chicago’s business retention, attraction and expansion efforts and raises the city’s position as a premier global business destination. (WBC 2010)</td>
</tr>
</tbody>
</table>
| Chicago Innovation Mentors (CIM) | Chicago Innovation Mentors supports university-based and local new technology innovation ventures through the use of mentor teams. CIM works with each science-based mentee venture to:  
  - Encourage innovation  
  - Catalyze tech commercialization  
  - Strengthen the ecosystem necessary to support entrepreneurs  
  - Enhance local economic development  
  - Create stronger entrepreneurs  
  - Embrace risk taking (CIM 2012)  
  - One interviewee points out that ‘CIM is where an experienced executive in biotech, whether it is legal, manufacturing, raising money, setting up a company, would come together and offer their services to start-up companies for free’. |
| Innovate Now | Innovate Now! is a joint initiative of the Chicagoland Chamber of Commerce, World Business Chicago and the Illinois Department of Commerce and Economic Opportunity to promote economic growth by promoting business innovation in key sectors of the economy.  
  - The goal is to make the Chicagoland region, and eventually the entire state of Illinois, a globally recognized center of innovation. Innovate Now! will be guided by a public-private leadership team of business, labor, education, government and civic leaders. (ICCB 2006) |

**Table 10 List of institutions and programs key to the Chicago cluster.**

In terms of exchanging information and communicating, Illinois is a strong case. To further communication beyond a core group in the network, the cluster has several mechanisms in place. First of all, the Office of Entrepreneurship, Innovation and Technology is currently thinking about a forum, which brings together big companies
with start-ups in the area. And already the process of potentially setting this up includes talks between the Office, CEOs and entrepreneurs to understand what the needs in the network are and in which ways people are willing to commit. Also, significant for the level of communication in the cluster is the lack of a marketing budget for the major organizations. This means that especially the Office and iBIO call, email and meet people to get the word out on new funding opportunities and events. Many stakeholders also have taken on more active roles in the cluster by connecting to other members. For example, the technology transfer offices at the universities are increasingly talking to industry and government. The technology parks around the city also organize gatherings and provide the physical space needed for networking events. A technology park representative pointed out a new program, the so-called ‘entrepreneur speed-dating’ where faculty members and serial entrepreneurs get together and researchers pitch their ideas in a five to ten minute talk.

Once they have gone through the first dozen pitches, the entrepreneurs score them and then we set up a second round of three dates of 20 minutes each and then they get a little bit more time and hopefully after that they found something that will lead into the formation of a company. (Technology park interviewee, March 2013)

Another communication and advice channel is ‘Chicago Innovation Mentors’ (CIM), which is a non-profit organization created by iBIO, the University of Chicago, the University of Illinois and Northwestern. CIM offers mentor teams to university-based and local new technology innovation ventures. As one interviewee from a technology transfer office points out,

they have been a catalyst for us to work closer with other universities as well as iBIO and then our mentor pool is people from industry, so it is now easier to talk to someone from Northwestern, because I see them at least once a month and I am on the phone with them almost every week in helping them run the program. (Technology transfer office interviewee, March 2013)

Communication opportunities are also available through the structural set-ups. Structural communication-enhancing elements are primarily connected to the Office or iBIO, including CIM, on-campus innovation and technology transfer offices, the science parks, the medical district or incubator facilities. They all contribute to the ecosystem and help foster formal and informal relationships. They also each have a defined role: While
organizations such as iBIO and the Office have the bigger picture in mind when connecting and fostering some of these structures, the two major technology parks, one in the area of Skokie and the university technology park at IIT, offer custom space to both multi-national companies (MNCs) and start-up companies. Their model is different to other science parks by trying to figure out what the universities are good at and known for and building off of that. This led the Skokie park to being a intersection between biotechnology and nanotechnology. For companies coming from outside of the US, the parks offer an entry point into the North American market in general and the cluster in particular. The on-campus innovation centres and the technology transfer offices as well as lab space on campus all offer an opportunity structure for researchers to interact with entrepreneurs and to facilitate translational research. In the innovation labs, ‘they can learn about patent laws, about costing a project and how to sell a project’. This makes the university lab space, as one entrepreneur emphasizes, a ‘turn-key solution’ for developing companies, because they are able to use otherwise expensive equipment and connect with other researchers.

The technology transfer offices as part of the structure of the ecosystem, have in recent years, in collaboration with iBIO, pursued a more active role. This also has to do – at least at the University of Illinois – with the change in the mission statement. As one interviewee describes:

They are active in seeking out disclosure, seeking out interaction with potential investors and company founders within their community, transforming that into protectable intellectual property when it is possible and giving them some connections and some guidance to the broader university community and the community in general around Chicago and it gets them financing, expertise and potential partners. (Technology Transfer Office interviewee, March 2013)

However, the changing demands towards universities not only in the Chicago area, put them in a position where their role in the network is not as easy to define anymore. Today, academic institutions are used for attracting and organizing industry-sponsored research projects, universities become part of state and regional economic development activities, they house start-up incubators and are engaged in general university-industry partnering (Tornatzky, Waugaman & Gray 2002). In other words, the presence of university research is not sufficient anymore to guarantee innovation and
technology-based spin-offs (Feldman 1994, Feldman & Florida 1994). This puts universities in a position in which it is difficult for them to strike a balance between their mission to educate and their hope to being able to commercialize. In Chicago, the university’s role is visibly shifting towards the translational side, as technology transfer offices become professionally managed by consultants. The University of Illinois, for example, just hired someone who solely focuses on entrepreneurial support and the incubator facilities.

In terms of resources, the university also functions as landlord by offering small wet labs\(^{38}\) spaces, which are hard to find and give start-ups the opportunity to have their own office. Renting or owning lab space is in turn needed for small companies to receive federal funding, as for example any SBIR funding requires companies to have ‘a place of business’ (SBIR 2013). Another resource available to companies in terms of financial support is the Invest Illinois Venture Fund (IIVF). The IIVF funds young, innovative firms and start-ups with money received through the federal state small business credit initiative (SSBCI) of the Small Business Jobs Act in 2010 (Illinois Department of Commerce and Economic Development 2013). From the total amount of $78 million, $20 million go into the venture fund, which supports small businesses during the time they need funding, but are not eligible for a credit yet. According to the Office of Entrepreneurship, Innovation and Technology the IIVF invested $5 million so far and has 18 portfolio companies right now. They are especially looking at local companies that are coming out of the iBIO PROPEL program. The fund is unique, because it is distributed by the government office itself, instead of contracting it out. The process to receive funding is straightforward in the sense that there is an online application, followed by an evaluation through five or six members of the 40 people-strong due-diligence committee, which includes iBIO. The committee scores the individual company and based on that score, entrepreneurs are invited for in-person interviews in front of committee members. Thereby, government is never the lead investor, because, according to the government interviewees, the office does not have the massive staff of investment bankers or

\(^{38}\) A so-called ‘wet lab’ is a laboratory equipped with the appropriate plumbing, ventilation, and equipment to allow for hands-on scientific research and experimentation – including chemicals drugs or other biological matter. Because those spaces are expensive to build and maintain, those labs are usually bigger in size and thus more expensive to rent and use.
venture fund experts they would need. Smaller companies coming out of university further have the opportunity to receive proof-of-concept funding\(^{39}\) from technology transfer offices. Those are rather small amounts – around ten to 20 thousand per company, but helpful to take a firm to the next step to attract bigger funding from government or venture capitalists.

With the goal of targeting bigger companies inside and outside of the US, the Office of Entrepreneurship, Innovation and Technology offers various tax incentives:

We can give them various tax deals on their property taxes, we can offset income tax liability depending if they have one, we can try and give them subsidized space for some period of time. If they have infrastructure needs, we can do investments and some kind of retrofitting of an existing space. Or, if they are going to build, we can give them money towards building. (Government interviewee, March 2013)

This means that the Office is relatively flexible in the way they offer tax cuts and can basically custom-tailor financial incentives for firms. However, many interviewees pointed out that Illinois is still missing venture capital and is in need of even more aggressive angel tax credit programme for investors. Looking at the distribution of venture capital in the US, it becomes clear that most of the money is still at the coasts. According to the Martin Prosperity Institute, the top five spots in 2012 for investments were San Francisco, San Jose, Boston, New York and Los Angeles. Thereby, San Francisco makes up 25 percent with $6.89 billion. Compared to Silicon Valley's dominance, Chicago ranks ninth with $547 million in investments and accounting for two percent (Nusca 2013). A similar picture emerges when it comes to human capital resources in the area. As one interviewee put it,

it is not so much that you need to get the capital, you need to get the people that the capital is willing to invest in. So we either need to attract people from the outside, or we need to better prepare people here. (Technology park interviewee, March 2013)

\(^{39}\) Proof-of-concept funding is defined as support aimed at helping to advance university inventions towards commercialization (UIC 2011).
And there are general hurdles connected to that. First, graduates and entrepreneurs still move away to the life science clusters in Massachusetts and California. Currently, the regional network is losing more members than it is attracting. ‘Each year, an estimated 8,841 25- to 35-year olds move to Chicago from metropolitan cities in the US, while 11,631 left Chicago, creating a net loss of 2,790 Chicago residents’ (Illinois Innovation Network 2013). On top of that, current immigration laws hinder Chicago in retaining highly-skilled human capital. In fact, interviewees repeatedly pointed that even with the support from companies and universities it sometimes is difficult to get visa extensions and green cards approved, which means that entrepreneurs take their ideas back to their home country, and essentially start creating jobs somewhere else. Also, they fear that as Asian cities are better prepared to house and support technology companies, some will decide to not enter the US at all. The numbers show that 40 percent of students graduating with a Masters or Doctorate degree in science, technology, engineering and mathematics (STEM) disciplines are temporary immigrant residents. In 2011, nearly 2,700 specialists in areas such as engineering or biomedicine were unable to obtain longer-term work visas after graduating from Illinois institutions (Illinois Innovation Network 2013).

Overall, the way the resource structure is set-up, especially for smaller and start-up companies, it supports the links among stakeholders. By keeping the investment fund ‘in-house’, the Office of Entrepreneurship, Innovation and Technology connects with experts in the life science sector and at the same time gains further insight into the companies and entrepreneurs in the cluster. The flexible tax incentives mirror company needs and establish communication channels between incoming firms, government and the community. Also, many of the grants offered are based on communication and feedback, like the entrepreneur speed-dating. The same applies to the current infrastructure in which innovation hubs and meeting spaces invite collaboration and networking.

Absorptive capacity

Some elements of Chicago’s support structure are based off of established clusters. For example, the mentoring service is modeled after the one at the Massachusetts Institute of Technology (MIT) in Boston. The MIT Venture Mentoring
Service (VMS) started in 1997 and matches prospective entrepreneurs with volunteer mentors (VMS 2008). The iBIO PROPEL approach is another model absorbed from outside of the cluster and put to use in the network. It is based on activities in San Diego. Beyond the Chicago Innovation Mentors, which are housed under the PROPEL roof, the iBIO program also offers coaching, business plan presentation panels, technical assistance, educational programs and business plan competitions. PROPEL mainly targets formation stage and early-stage companies and so far worked with around 40 companies in the last four years.

According to the interviewees the biggest opportunity for knowledge spillovers, as part of the cluster’s absorptive capacity, are the hubs around town. These include the shared lab spaces on campus at the different universities or in the Illinois Medical District (IMO) as well as ‘1871’. 1871 is a digital start-up hub operated by the non-profit Chicagoland Entrepreneurial Center (CEC) and offers access to mentors and resources as well as various networking opportunities. In recent months some members of the life science community started moving in, including iBIO. In fact, future plans by Chicago’s mayor Rahm Emanuel include opening a tech incubator similar to 1871 for life sciences. Several start-ups have already expressed interest in becoming part of the project and iBIO, among other network members, has signed on as a founding member.

The collaborative and absorptive capacity elements in Chicago are summarized in Table 11.

<table>
<thead>
<tr>
<th>Collaborative Capacity Framework</th>
<th>Basic elements</th>
<th>Collaborative activities</th>
<th>Yes</th>
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<td>Shared Vision</td>
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<td>Network membership</td>
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<td>Clear Roles</td>
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### Table 11 Chicago’s collaborative and absorptive capacity.

<table>
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<th>Absorptive Capacity Framework</th>
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<tr>
<td>Extra-cluster knowledge system</td>
<td>Extra-cluster knowledge sources</td>
<td>Linkages to those sources</td>
<td>x</td>
<td></td>
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<tr>
<td></td>
<td>Interface between the external linkages and the intra-cluster knowledge system</td>
<td>Acquiring new knowledge from extra-cluster sources and transferring knowledge to intra-cluster firms</td>
<td>x</td>
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5.2.2. **Concluding remarks**

Chicago is part of the emerging life science clusters in the US. While the established clusters are still located at the coasts, the emerging ones show that innovative processes are taking root in other states. Illinois, particularly the Chicago area, is home to several top research universities and institutes and was so far able to
attract some of the big names in pharma. But the region is still struggling to build a start-up community, as researchers and entrepreneurs often choose to move to the coasts (JLL 2011). This trend is true for researchers and companies alike. Interviewees raised the concern that Chicago’s educational institutions educate scholars, which then relocate to the more prestigious clusters in Massachusetts or California. However, company stakeholders also have hope that those entrepreneurs drawn to the coasts will eventually come back or uphold ties to stakeholders in the Illinois area.

Chicago stakeholders attribute part of the city’s competitiveness to the lower cost of living compared to other regions, which also means lab space is more affordable and there is more flexibility in offering these spaces. Geographically, Chicago has an advantage as it has good connections to any bigger city in the US and Canada as well as to both coasts. People in the US are also becoming more aware of Chicago as a hub, which was further fuelled by having the BIO convention in town. Current strategy documents also reveal that Illinois will make use of the bigger biotech community in the Midwest to compensate for the knowledge accumulation in leading clusters. Government is further targeting the start-up community with federal funds and attracting bigger companies to the area. Both strategies aim at job creation and learning enhancement, as (1) foreign firms create spillovers for the local environment, because R&D sites provide employment and learning opportunities (Kuemmerle 1996; Serapio & Dalton 1999), and (2) moving away from the idea of a lone inventor or risk-taking entrepreneur, but rather providing hubs and collaboration facilities (Feldman & Florida 1994).

These efforts bare fruits as Illinois has ‘a large, diverse and well-concentrated industry base in the biosciences with nearly 80,000 jobs that span 3,424 individual business establishments’ (Biotechnology Industry Organization 2012, 72). The state further has employment concentration in drugs and pharmaceuticals, agriculture feedstock and bioscience-related distribution. Illinois ranks fifths in drugs and pharmaceutical manufacturing, behind California, New Jersey, Pennsylvania and North Carolina. The cluster management structure is unique in the sense that the government office’s responsibilities for funding and support are informed by an entrepreneur who was not only able to create the Office of Entrepreneurship, Innovation and Technology, but also streamline the funding application process in a way that makes sense to entrepreneurs. iBIO on the other hand does not seem to obviously claim any leadership
position in the cluster, however is involved in most of the ongoing operations and networking events.

This snapshot of Illinois’ life science cluster shows that government is focusing on creating an entrepreneur-driven culture, however retaining start-ups and smaller companies will continue to be a major challenge. The government and iBIO seem to favour and foster new firm formation, which is a key aspect of cluster success. As Hakanson (2005) points out, entrepreneurship and new firm formation provide the ‘decisive input for economic growth and innovation’ (Ibid, 447), due to the importance of ‘perceived opportunities’.

**Facilitator model**

The Chicago case portrays a facilitator model, which is independent. It is heavily funded by industry and officials have no regulatory power over the organization, however informal ties with government are strong. iBIO, as the cluster manager, is a life science industry association composed of international as well as small- and medium-sized companies in the agricultural and human health sector, entrepreneurial leaders of start-ups and spin-offs, scientists and technology transfer specialists, venture capitalists, seasoned government people, service providers from major law, accounting financial and research firms as well as a variety of business professionals. This mix of people helps to accommodate the various needs of stakeholders. As in the previous facilitation model by Medicon Valley, iBIO also has a learning component to its practice. Former entrepreneurs and life science experts bring in experiences from established clusters, leading to the adoption of current mentoring and funding services. Some more unique features of this model include the fact that iBIO is part of an umbrella organization, BIO, which offers access to additional services, funds and networking with other parts of the country.

Further, iBIO has a government counterpart in the Office for Entrepreneurship, Innovation and Technology. The office makes government accessible for cluster needs and helps to maintain a strong link between cluster and government officials. iBIO was also able to establish smaller sub-divisions for more specialized services, such as PROPEL. This way the institution can tailor to the needs of network members with the according personnel, funding and government support. Overall, iBIO gained trust by
being part of a bigger, already established organization and having people involved, who are well-known in the industry. The link to government is pursued through personal relationships in the rather small life science community and enforced by the fact the government has something to offer through such a specialized office. The perception is that the accessibility to government might be harder in other states, where government does not have a specific office and trust is also harder to establish if the facilitator is not part of a larger organization or lacks the according experienced personnel for support.

5.3. Singapore

Compared to the two previous cases, the biomedical development in Singapore is predominantly orchestrated by government. Officials started out by establishing a Life-Science Ministerial Committee (chaired by a deputy prime minister) to oversee long-term strategy formulation, followed by instituting a highly coordinated implementation approach involving the Economic Development Board (EDB), the Agency for Science, Technology and Innovation (A*STAR), and the Ministries of Education, Manpower and Health (Finegold, Wong & Cheah 2004). As most interviewees pointed out, the entire history of the life science field in the city-state followed a planned and focused approach. This was mostly done to compensate for the lack of natural resources and declining numbers in manufacturing. Singapore is also seizing what some call the ‘second-mover advantage’, where the uncertainties of first-order technological innovation have been managed elsewhere and late-entry countries like Korea, Taiwan or Singapore upgrade to already ‘mature technologies’ (Wong 2011).

Generally speaking, the Singapore cluster is considered ‘young’. With its creation in 2000, it so far only had 13 years to catch up to other life science networks. This is not a long time considering the fact that drug development takes about ten years before it reaches the stage of commercialization. Focusing on the establishment of the biomedical field, there was a shift in the role of the state around the Asian economic crisis (1997/1998) towards regulation, including market liberalization, policy deregulation and the privatization of government-linked companies in Singapore (Yeung 2010). Also,
as government worked out a growth strategy for the country, it turned towards a tripartite arrangement with trade unions, the business community and the public sector. ‘Co-option of the parties was seen as the pragmatic way of addressing the challenging problem facing the new city-state’ (Kumar & Siddique 2010, 7). This laid the groundwork for a still present mantra of an investment-led and export-driven ethos in Singapore. Fueling this approach is the strength of the Economic Development Board (EDB) with its goal of attracting foreign investments. Ultimately the EDB has become an integral actor in the science and technology development strategy.

The functions of the EDB include the formulation and implementation of economic and industrial development strategies and transforming Singapore into a global hub. EDB’s board members are a mix of public and private sector leaders. However, the public sector members largely belong to the EDB, the Ministry of Trade and Industry and the National Trade Union Congress, which leads to a ‘bias towards a larger private sector component’ (Kumar & Siddique 2010, 18). Hence, the board structure resembles the tripartite approach to planning in Singapore.

In tandem with the EDB, the Agency for Science, Technology and Research (A*STAR) focuses on the support of biomedical science. A*STAR, the former National Science & Technology Board, is a statutory board under the Ministry of Trade and Industry. It is a R&D funding body and crucial R&D performer at the same time, due to the many research institutes under its lead. With the type of funding and the research focus, A*STAR guides the cluster and structures the relationships among stakeholders. Since the launch of the Biomedical Science (BMS) initiative in 2000, A*STAR has further developed key capabilities to develop this sector as the fourth pillar of Singapore’s economy, alongside electronics, engineering and chemicals (A*STAR 2011).

A*STAR proactively engages industry at various stages of the research and commercialization continuum to facilitate knowledge and technology transfer in both directions, as well as to ensure better

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40 The tripartite model underpins public/private cooperation in Singapore since the early 1960s. The cooperation includes workers, labour unions and the government and is based upon a productivity principle – bonuses depend on company performance and for civil service employees, the performance of the Singapore economy in general (Kumar & Siddique 2010).
alignment between upstream research and downstream commercialization efforts. (A*STAR 2011, 8)

Thereby, A*STAR services the whole value chain, starting with supporting talent, up to incubating start-up companies.

On top of that, A*STAR provides scholarships to Singaporean students to raise the number of PhD students and contribute to the levels of human capital. The agency further recruits renowned scientists to lead its research institutes. Some of the famous names include Professor Sir David Lane (co-discoverer of the p53 gene and founder of Cyclacel), Professor Sir George Radda (pioneer of nuclear magnetic resonance imaging and former Chief Executive of the UK Medical Research Council), Professor Edison Lin (former Director, Division of Clinical Sciences, National Cancer Institute, National Institute of Health), and Professor Jackie Ying (former professor of chemical engineering, Massachusetts Institute of Technology) (A*STAR 2011, 24). Those scientists helped jump-start biomedical science efforts, providing leadership to the research community and mentorship to young local scientists. A*STAR also nurtures entrepreneurial activities through gap and seed funding, technology incubators, mentorship and role models – through the A*STAR-MOE-SPRING-GET-up programme. Geared towards new companies, A*STAR’s Exploit Technologies agency services the industry-research interface where teams of technology transfer professionals harness new technologies, increase the value of intellectual property and incubate business ventures to create commercial impact. To pursue all of the above activities, A*STAR will receive S$6.39 billion (~US$4.98) throughout the 2011-2015 funding cycle (A*STAR 2011). Overall, A*STAR (2011) describes itself as being closely aligned with industry needs through five mechanisms: (1) engaging the industry; (2) facilitating the use of intellectual properties (IPs); (3) securing gap funding; (4) encouraging entrepreneurship and commercialization, and (5) spurring new growth through open innovation. The general set-up suggests that not only the vision of

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41 To make the combined resources of A*STAR, the Ministry of Education and research institutes available to companies, GET-Up involves an initial company visit to understand areas of required assistance and tailoring existing financial schemes and possible technical assistance accordingly (A*STAR GET-up 2009).

42 This is a 19% increase from the S$13.55 billion allocated for 2006-2010 (A*STAR 2011).
Singapore is targeting industry connections in form of multi-national companies (MNCs) coming to and investing into Singapore, but also the structural composition of the according universities and government departments.

Singapore’s general vision focuses on industry inclusion and greater involvement of all stakeholders in the life science field. The government points out that the Biomedical Science initiative will work towards greater integration (1) across various players of the BMS ecosystem to facilitate the translation of research into applications for better economic value; (2) across the entire value chain from basic, translational and clinical research, process R&D to manufacturing (A*STAR 2011). Thereby, A*STAR is an integral part of managing and structuring that ecosystem, while being entrenched in research and commercialization activities itself through its numerous research institutes. In this, it differs from other cluster managers in the sense that the agency combines government and research while connecting other players in the network.

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<tr>
<th>Initiatives/ Organizations</th>
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<tr>
<td><strong>Agency for Science, Technology and Research (A*STAR, former: National Science and Technology Board)</strong></td>
<td>• In 1991, the National Science &amp; Technology Board (NSTB) was set up, under the Ministry of Trade and Industry (MTI), with the primary mission of raising Singapore’s capabilities in S&amp;T. In 2002, to highlight Singapore’s emphasis on the creation and exploitation of intellectual capital and the training of research manpower in its transition to a knowledge-based economy, the NSTB was renamed as the Agency for Science, Technology and Research (A<em>STAR). (A</em>STAR 2011,13). A<em>STAR is the lead agency for fostering scientific research and talent for a knowledge-based Singapore. A</em>STAR actively supports public sector R&amp;D in biomedical sciences, physical sciences and engineering, and supports Singapore’s key economic clusters by providing intellectual, human and industrial capital to partners in industry and the healthcare sector. A*STAR’s R&amp;D strategies are closely integrated with Singapore’s economic development strategies, and these enable Singapore to attract R&amp;D projects with multi-national companies (MNCs), widen industry reach and help local enterprises upgrade (Ibid, 15).</td>
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<tr>
<td><strong>Biomedical Research Council (BMRC)</strong></td>
<td>• Established in October 2000, the Biomedical Research Council (BMRC) supports, oversees and coordinates public sector biomedical research and development activities in Singapore (A*STAR 2012a).</td>
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<td><strong>Biomedical Science (BMS) initiative</strong></td>
<td>• The Singapore Biomedical Sciences (BMS) initiative was launched in June 2000 to develop the Biomedical Sciences cluster as one of the key pillars of Singapore’s economy, alongside Electronics, Engineering and Chemicals. The initiative is currently in Phase 3 (2011-2015): Building on this foundation created over the last 10 years, BMRC will support the next phase of the BMS Initiative through focusing its efforts in 3 main areas to capture the growing opportunities arising from global trends in the BMS industry: (1) enhanced Industry engagements for greater economic outcomes; (2) focusing on mission-oriented programs with high growth potential, and (3) seamless integration and translation as key competitive advantages (A*STAR 2012b).</td>
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<td><strong>Economic Development Board (EDB)</strong></td>
<td>• EDB is the lead government agency for planning and executing strategies to enhance Singapore's position as a global business centre. We dream, design and deliver solutions that create value for investors and companies in Singapore (EDB 2012).</td>
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<td><strong>Exploit Technologies</strong></td>
<td>• Commercialization arm of A*STAR</td>
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<td><strong>International Enterprise Singapore (IE, former: Trade Development Board)</strong></td>
<td>• IE Singapore is the government agency driving Singapore's external economy. For the past 30 years, we have been spearheading the overseas growth of Singapore-based companies and promoting international trade (IE Singapore 2012).</td>
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<td><strong>Industry Development Group (IDG)</strong></td>
<td>• IDG helps A<em>STAR researchers succeed in drug discovery and development by advancing and developing commercial outcomes from their early-stage discoveries for the benefit of the researchers, A</em>STAR, the Singapore economy and society (BMS Institutes 2010).</td>
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<td><strong>Ministry of Education (MoE)</strong></td>
<td>• The Ministry of Education directs the formulation and implementation of education policies. It has control of the development and administration of the Government and Government-aided primary schools, secondary schools, junior colleges, and a centralized institute (MoE 2013).</td>
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<td><strong>Ministry of Health’s (MoH) National Medical Research Council (NMRC)</strong></td>
<td>• NMRC funds and supports public research initiatives, as well as awards medical research fellowships for the development of medical research manpower.</td>
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<td><strong>Ministry of Trade and Industry (MTI)</strong></td>
<td>• Ministry of Trade and Industry (MTI) promotes economic growth and create jobs, so as to achieve higher standards of living for all by: (1) facilitating the development of industry sectors with strong growth potential and fundamentals; (2) protecting Singapore’s international trade interests, in particular, with a view to enhance</td>
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access to global markets for goods, services and investments, and (3) providing a good understanding of the current state of and outlook for the Singapore economy for policy formulation and refinement (MTI 2012).

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<tr>
<th>Research, Innovation and Enterprise Council (RIEC) &amp; National Research Foundation (NRF)</th>
<th>• The Research, Innovation and Enterprise Council (RIEC) and the National Research Foundation (NRF) were set up in 2006 under the Prime Minister’s Office to lead and coordinate the research of different agencies, within a larger national framework, in order to provide a coherent and comprehensive strategic overview and to help advance Singapore’s National R&amp;D Agenda (A*STAR 2011, 15).</th>
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<td>Singapore Biomedical Sciences Industry Partnership Office (IPO)</td>
<td>• A<em>STAR, EDB and NMRC have also jointly set-up the Singapore Biomedical Sciences Industry Partnership Office (BMS IPO) to serve as the one-stop coordinating office between the various research agencies and performers in Singapore with MNCs seeking to establish multi-party collaborations (A</em>STAR 2012b).</td>
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<tr>
<td>SPRING Singapore (former: Productivity and Standards Board) – Technology Innovation Program (TIP), TECS, TIS</td>
<td>• SPRING is the enterprise development agency for growing innovative companies and fostering a competitive small and medium enterprise (SME) sector, to upgrade the technology capabilities of local enterprises by providing support such as financing, capability and management development, technology and innovation, and access to markets (A*STAR 2011, 16)</td>
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<tr>
<td>SPRING Startup Enterprise Development Scheme (SPRING SEEDS)</td>
<td>• SPRING SEEDS Capital Pte Ltd (SSC), a wholly-owned subsidiary of SPRING Singapore, manages the SPRING Start-up Enterprise Development Scheme (SPRING SEEDS), an equity-based co-financing option for Singapore-based start-ups with innovative products and/or processes with intellectual content and strong growth potential across international markets (SPRING Singapore 2013).</td>
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**Table 12 Key government departments and programs connected to biomedical science in Singapore.**

Table 12 summarizes the main government departments and programs connected to biomedical science in Singapore and reveals some of the range of departments involved, their sub-units and joint programs. This complex structure of government departments and branches as well as programs and joint ventures is simplified by more or less having the same people in charge. In fact, there is one core group of members in all committees. This is due to the fact that Singapore has had one
dominant single party in power from the day it became ejected from Malaysia. ‘A political party that has been in power for so long and which has integrated the public sector decision-making capabilities to its own enables public servants to also act in unison with decisions made by the political hierarchy’ (Kumar & Siddique 2010, 13). Further, all agencies have allowed civil servants into government positions who have close relationships to cabinet members long before entering the position. Many civil servants go through the same scholarship program. They form a bond before they enter office and create trusting relationships throughout their career. In biomedical science, A*STAR was created under the guidance of the former head of the EDB, Philip Yeo, who had been instrumental in restructuring the manufacturing sector in earlier years. ‘The trust that ensues from such working environment then provides the glue with which critical agencies are managed from the centre’ (Kumar & Siddique 2010, 13). Thus, the Singapore network not only portrays a top-down model in the way the cluster is managed, but also a very centralized and uniform one. The following section will further explore these dynamics from the perspective of collaborative and absorptive capacity.

5.3.1. **Collaborative and absorptive capacity**

**Collaborative capacity**

The Singaporean government gave the cluster a purpose by launching the Biomedical Science initiative (2000). The goal was to make this sector the fourth pillar in Singapore’s economy. Officials also linked the establishment of A*STAR to this step by renaming the National Science and Technology Board in 2002, to ‘highlight Singapore’s emphasis on the creation and exploitation of intellectual capital and the training of research manpower in its transition to a knowledge-based economy’ (A*STAR 2011, 13). This makes A*STAR the lead agency for all things connected to biomedical science. The mechanisms fostering this leadership position include, as pointed out earlier, the continuity in personnel. As one interviewee highlights:

43 The civil service system in Singapore dates back to its founding in 1819 and today the Public Services Commission (PSC) awards scholarships, selects future civil servants, grooms and deploys them and tracks their progress and performance. To attract talent, Singapore civil service and political office holders are some of the highest paid in the world (Kumar & Siddique 2010).
If you look at A*STAR’s leadership for the last ten years, we basically have two leaders and you need that, because you need time to built up the relationship with the academics across the world, you need time to built up the relationship with the talent you bring up in Singapore an then the industry parties. (Research institution interviewee, February 2013)

Further, A*STAR is part of all the processes ongoing in the cluster. The agency identifies and develops R&D agendas and strategies for the biomedical field, it engages industry at various stages of research and commercialization and also carries out government goals. It manages the overall development budget for research and administration and monitors the programs being pursued by the institutes. As part of the strategic vision, the government made a S$16.1 billion (~ US$12.6 billion) commitment to research and innovation for 2011-2015 under the Research, Innovation and Enterprise (RIE) plan. This is an increase of 19 percent over the previous five-year period and funnels one percent of the expected Gross Domestic Product (GDP) to public sector research and innovation (A*STAR 2011).

Overall, the BMS portfolio has progressed from the general target area of biomedical into five key areas in which Singapore is expected to thrive: (1) drug discovery; (2) bio-imaging; (3) stem cells; (4) cohort studies, and (5) biomarkers. These rather translational programs will then interface with the basic biomedical core capabilities (MTI 2006). The allocation of leading pharma companies such as GlaxoSmithKline, Genentech, Roche, Lonza, Baxter and Novartis also fuelled the progress of the program. This larger shift in strategy did trickle down to the researchers working in the labs, as one of them points out:

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44 Previous plans were focused on firm foundation and basic biomedical research (2000-2005) and strengthening translational and clinical research (2006-2010).

45 Some interviewees pointed towards stem cell research as a possible competitive advantage for Singapore’s future research profile and government already laid the basis in terms of (ethics) regulation. ‘The Bioethics Advisory Committee was formed in 2001, at the time of the US stem cell controversy, to develop recommendations on the legal, ethical and social issues of human-biology research. The government accepted the Committee’s recommendation that human cloning not be permitted, but doing stem cell research or the use of cloning as a therapeutic tool is to be allowed. This early and clear legal support for stem-cell research, plus government financial support, has helped Singapore create several stem cell companies’ (Finegold, Wong & Cheah 2004, 924).
In the past it was quite broad, in the past we did agriculture in Singapore, there are still institutes that focus more on the clinical side, more on healthcare. So the trend is more going towards translational medicine, where your research is really put into use for patients with needs. (Research institute interviewee, February 2013)

Further, as a visible commitment to the life science industry, Singapore built two state-of-the-art biomedical research parks. 'Biopolis', a S$300 million project with 190 hectares of buildings, is home to public as well as corporate research laboratories. The technology center brings together over 2,000 scientists, researchers, technicians and administrators in one location (Finegold, Wong & Cheah 2004; A*STAR 2009). Some of its anchor tenants are five of A*STAR's biomedical research institutes as well as GlaxoSmithKline and Proctor & Gamble. For the future development of this space, government hopes that more social spaces will evolve for informal networking and ultimately attracting a critical mass of biomedical expertise. The second complex built to house research institutes is 'Fusionopolis'. Together, Biopolis and Fusionopolis are strategically co-located at 'one-north' – an area of Singapore, where many research institutes and universities agglomerate. Beyond these two hubs created by government, many firms also settled into a separate Science Park. It is located along Singapore’s Technology corridor and in close proximity to research and tertiary institutions such as the National University of Singapore (NUS), the National University Hospital (NUH) and one-north.

This ties in with the structural aspects that characterize the cluster, including formal and informal procedures as well as the roles ascribed to players in the network. The short distances in the city-state were mentioned many times as an advantage to meet in a more informal manner. The set-up of Biopolis enhances some of the informal communication; however, critiques also pointed out that the costs of renting space in the new buildings and the long-term contracts they already have with landlords, prevent them from moving in.

Another structural element is the recent change in funding. This led to higher levels of collaboration among stakeholders, which is in line with A*STAR’s mission to enhance the ecosystem in BMS. For some of the research institutes, funding used to come directly from A*STAR in five-year chunks. Thus, when meeting performance targets, every five years, new and often more funding would be provided. Today, for
institutes such as the Singapore Immunology Network (SIgN), 75 percent of the funding is provided by A*STAR, while 25 percent has to be attracted through collaborative projects with other institutes or preferably industry. According to stakeholders, this encouraged some institutes to sell their equipment that existed in duplicates during the time when more funding was available. By sharing some of the machines in laboratories, more people are getting in touch with each other and find common ground to collaborate or exchange knowledge. However, this aggressive shift is a challenge for some, as Singapore is still a growing cluster compared to other life science hubs and ‘heavily driven by risk-averse academics and government-funded scientists’ (Lee 2012). Talking to A*STAR officials, the general mindset seems to be that by creating incentives for stakeholders to collaborate, it ultimately prepares researchers to compete for grants inside and outside of the country. This line of argument, reflected in the funding structure, is an indicator for a more general attitude of not doing R&D for R&D sake, but having a clear plan about the outcomes, as this statements from one official shows:

> It is one thing if you get good journal articles and peer review, but we really get excited if the industry is interested in what you are doing. Until that happens, it is just having fun on our account. (Government interviewee, February 2012)

At the same time, however, Singapore is able, through a wealth of funding, to offer long-term grants which make it easier to attract researchers as they do not have to live on a project-to-project basis. Also, as the grants run longer, researchers work together over longer periods of time and are able to build relationships and trust.

Favourable networking conditions are also linked to the government set-up. A*STAR can generally tap into a wide network of well-known CEOs and scientists. Also, due to the fact that A*STAR monitors the whole commercialization process, funding gaps can be identified quicker and filled through departments branches such as Exploit Technologies. In fact, many interviewees pointed towards the business-like structure of the Singapore government in general and A*STAR in particular:

> The unique difference between this environment and other countries is the government basically operates like a business – they are very strategic and very smart about it, other governments work more towards a constituency base and are more preoccupied by politics and
less about where the country is going. (Biotechnology company interviewee, February 2013)

However, other Singapore industry stakeholders painted a more cautious picture. Because A*STAR acts as a business partner to companies, the recent funding cuts, according to them, send a signal of less spending and might scare off investors. Some of the links to industry therefore could be endangered with the change in the funding structure. Overall, Singapore profited from the government-driven structure for the initial push of BMS, however it is getting more complicated as the network spreads. At the same time, the relationship between the EDB and A*STAR is changing and is becoming less structured. After working in tandem with the Economic Development Board, A*STAR is now moving on to taking a more obvious lead in some of the sector’s developments (Kumar & Siddique 2010).

Compared to other clusters, communication among stakeholders is rather limited. Stakeholders highlighted formal communications, such as board meetings, but rarely mentioned any informal networking events like the ones in Medicon Valley or Chicago. A*STAR made an attempt to increase informal collaboration through the funding cut, which led some institutes to share equipment. However, while interviewees did point out that people are better informed about the research going on in other labs, there was no immediate evidence that this information transformed into regular communication or joint projects. Further, regular communication seems to be largely limited to government circles and the technology-push\(^46\) side of the cluster. For the latter, this means that most communication is concerned with the translation of research into an innovation. Research institutes take to officials and sub-divisions for transforming their findings into a product. This usually includes A*STAR and/ or Exploit Technologies and a small group of researchers involved in the project. After that, communication with possible angel investors or companies begins. This defines a lot of vertical communication within the network, but also reveals lower levels of horizontal relationships among scientists.

\(^{46}\) In contrast to ‘demand-pull’, the ‘technology-push’ model highlights ‘the the key role that science and technology play in developing technological innovations and adapting to the changing characteristics of the industry structure. On the other hand, scholars embracing a demand-pull approach identified a broader set of market features, including characteristics of the end market (particularly, the users) and the economy as a whole, that affects the performance of innovation’ (Di Stefano, Gambardella & Verona 2012, 1283).
In government circles, many officials know each other either from earlier cooperation in other departments or because they were part of the same pool of recruits. This creates a culture of bonding among government employees and helps with the creation of a network in these circles (Kumar & Siddique 2010). To carry this culture forward and enhance stakeholder connections, especially across disciplines, A*STAR announced recently that there are plans to implement virtual joint councils:

The virtual network will make use of a hub-and-spoke model\(^{47}\) of resource allocation, compromising a hub of a core group of researchers working in a centralized location in the host RI, supported by distributed sub-groups located in each collaborating RI. (A*STAR 2011, 80)

In various aspects, resources are a hot topic in Singapore right now. This is not only related to the recent change in funding, but also to an immigration discussion. It comes down to the fact that, as one interviewee points out, ‘Singapore researchers have the money to buy expensive equipment and open programs, however, they still need the people to operate the equipment and that supply is limited’. This means that the long-term funding structure might work in the city-state’s favour, however Singapore still is lacking skilled people to fill positions and ultimately needs to ‘import’ human capital. In other words, one major challenge for the life science sector currently is the lack of qualified personnel. Many describe the issue as still in ‘catching-up’ mode, including programs like the A*STAR scholarships. To prepare students for careers in science and to prevent brain drain, A*STAR offers scholarship programmes in which the government covers tuition fees and living expenses at universities in North America and Europe upon the condition that candidates return to Singapore and contribute to local research institutions for three to six years. Education programs also happen in collaboration with pharmaceutical companies\(^{48}\), such as Merck Millipore. As one consultant connected to the training program explained:

\(^{47}\) The Hub & Spoke model is used in the context of multi location sourcing wherein a central consolidator called the ‘Hub’ provides a single face to the customer while seamless extensions called ‘Spokes’ are leveraged to provide the services, distributed across multiple locations (KPMG 2012b).

\(^{48}\) Part of the STEP program.
There are different programs, there is one program where some students can join a company and then go out of Singapore to the parent company – this could be in the US or Europe – work there for a certain period and come back. The other approach is where they certify certain training organizations in Singapore who can provide quick trainings in diverse areas that cater towards biopharmaceuticals. (Biotechnology company interviewee, February 2013)

In connection to building a life science workforce, local company leaders voiced concern about the fact that many Singaporeans do not stay with one company over long periods of time, which means they are trained by their employer and then leave. Also, many high-ranking positions within, for example, international companies in Singapore are occupied by foreigners who build up the branch over a certain period of time. After that, there are often no locals able to fill their position based on training and education. Naturally, this shifts the focus towards attracting human capital from other parts of the world. Something that has been ongoing since the manufacturing age in Singapore. Recently, however, there has been a change in attitude and political climate regarding the influx of foreigners. The ‘Population Whitepaper’ (2013) by the National Population and Talent Division highlights that Singapore cannot allow an unlimited number of foreign workers into the country: ‘We do not want to be overwhelmed by more foreign workers than we can absorb, or to expand our total population beyond what our island is able to accommodate’ (Ibid, 5).

In advertising a controlled immigration rate, Singapore hopes to have a steady permanent residents rate between 0.5 and 0.6 million and a projected citizen population between 3.6 and 3.8 million by 2030. The National Population and Talent Division also pushes for a shift in the division of the work – in which Singaporeans upgrade themselves into higher, skilled jobs, such as professionals, managerial, executive and technical (PMET) jobs, while more of the lower-skilled jobs will be done by foreigners. Still, up to this point, Singapore needs highly-qualified people to come in for a variety of reasons. First, they have been recruiting star scientists, researchers known in their field, to mentor and guide Singaporean talent and to attract foreign researchers and investors into the country. Some of these big names are leaving again and as one interviewee points out, this could become problematic:

Big names really drive research and innovation, but because of this funding change those people are leaving now and I think the risk they
face is going to be the same risk that they are going to face on the commercial side – the for-profit organizations, where the people driving the people, having the vision aren’t the Singaporeans. Unless they get the Singaporeans up to speed quickly on thinking that way, there is not going to be the talent here to drive it for them. (Research institute interviewee, February 2013)

Beyond those star scientists, Singapore’s only ‘treat’ for incoming researchers is a tax reduction on their salaries. This is tricky, because they basically offer the same salary as other countries, just with lower taxes. And, as one interviewee points out, ‘people do not usually care about that, they want to move for a salary increase and if the tax is less – this is a bonus, not a reason’. On top of that, housing costs have been rising and the general costs of living have gone up. This mostly applies to researchers listed by A*STAR or other research institutes. For company employees, it seems, Singapore is still attractive. This has to do with the fact that many bigger firms pay rental fees and moving costs. Further, Singapore offers a secure, English-speaking environment with many highly-ranked international schools and a good infrastructure.

To sum up the resource issues in Singapore, the city-state in general and A*STAR in particular are committed to training Singaporeans to fill high-ranking positions as well as staying attractive for big names. There was, however, an underlying doubt in many of the research institute directors’ interviews about the entrepreneurial culture of Singapore. They pointed out that the hierarchical thinking and the notion of secure jobs rather than uncertainties connected to a spin-off and start-up companies, might prevent at least this generation of researchers to thrive in life sciences. The government hopes to change this by training students outside of the country and portraying entrepreneurs as role models, as recently done in a local newspaper series. The same is true for the investment community, where risk-takers are needed to invest in new companies and products.

49 Interviewees pointed out that the local newspapers have started to more prominently present local entrepreneurs. For example, the ‘Strait Times’ has an ongoing series called ‘SME Inc’ in which it portrays company founders in Singapore. There is also a general trend to change the culture of failure being unacceptable (Syed 2012).
Absorptive capacity

The other capacity crucial for the development of the cluster, which is facilitated by A*STAR, is the ability to absorb knowledge from other networks, identify knowledge gaps within the cluster and react to change (Narula 2004; Giuliani 2005). Generally speaking, the Singapore model is a combination of best practices from around the world and the city-state further makes an effort to be connected to successful networks either at a research or political level. The openness of Singapore towards foreign workers and investment early on led to a ‘tacit acceptance that there are lessons from elsewhere that can be adapted for Singapore’ (Kumar & Siddique 2010, 4). And it seems that there is a learning process ongoing in which MNCs complement local knowledge as well as create knowledge spill-overs, including managerial and technical competencies and information on international markets (Belussi & Sammarra 2010).

Inspired by Porter’s cluster theories, different agencies borrowed ideas for the Science Park and Biopolis from the North Carolina Research Triangle, the Boston Science Belt and Silicon Valley (Kumar & Siddique 2010). A*STAR also operates research platforms where scientists from Singapore collaborate with foreign researchers to exchange knowledge. For example, in 2009, A*STAR announced a collaboration with the Centre for Integration of Medicine and Innovation Technology (CIMIT), a consortium of Boston-based hospitals and engineer schools. The goal was to create ‘greater opportunities for impactful innovations in the areas of medical technology (medtech)’, and more importantly provide ‘an environment conducive to training innovators for the growing medtech industry in Singapore’ (A*STAR 2011, 58). Early on, Singapore also profited from researchers who were part of the Silicon Valley wave and then moved back to Singapore, bringing tacit knowledge of cluster evolution and networking with them. And even today, such a transnational community of elite professionals and

50 ‘In the 1950s, North Carolina was home to a deteriorating economic base rooted in tobacco, furniture manufacturing, small-scale farming and textiles, and had the second-lowest per capita income in the nation. The state’s economic future was uncertain. But in 1959, a group of the state’s brightest political, business and academic leaders created a new future for North Carolina. Together, they worked to create a more sustainable economic base that would carry North Carolina into the 21st century. Drawing upon the strengths and synergies between North Carolina’s academic, government and industry base they created RTP [Research Triangle Park] as a place to attract and grow research and development (R&D) operations’. (RTP 2011)
entrepreneurs fostered by A*STAR exists. Stakeholders go into successful US clusters and then come back, while keeping in touch with the network (Yeung 2010).

Complementary to A*STAR’s work, the Economic Development Board has the goal of developing Singapore ‘into a global city with total business capabilities by attracting foreign investments, developing local enterprises as well as implementing, strategic overseas projects with significant linkages to Singapore’ (Kumar & Siddique 2010, 17). This is done through their offices in key locations around the world. The Board has sites in China, France, Germany, Sweden, UK and the US. This poses a communication and knowledge-exchange channel with other clusters, such as Boston or Medicon Valley and thus enhances absorptive capacity in terms of knowledge inflow. Already in the early 1980s, the EDB established a venture capital office in the US to invest in DBFs, establish networks and create global visibility for Singapore among US venture capitalists.

The primary objective at that stage was to use venture funding, and the access it provided, to some of the leading first-generation DBFs so as to learn about the biomedical science industry, rather than to attract companies to Singapore. It was only from the late-1990s that EDB began selectively to invest in DBFs that were willing to bring key new technologies and generate higher value-added research jobs in Singapore. (Finegold, Wong & Cheah 2004, 923)

Overall, Singapore possesses some of the collaborative and some of the absorptive capacity features (see Table 13 for details).

<table>
<thead>
<tr>
<th>Collaborative Capacity Framework</th>
<th>Basic elements</th>
<th>Collaborative activities</th>
<th>Yes</th>
<th>In Progress</th>
<th>No</th>
</tr>
</thead>
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<tr>
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<td>Leadership</td>
<td>Identification of leadership role</td>
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<tr>
<td>Shared Vision</td>
<td>Mission statement/agreement</td>
<td>x</td>
<td></td>
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<tr>
<td>Network membership</td>
<td>Connection to a broader functional network</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td>Formal and Informal Procedures</td>
<td>Memorandum/interagency planning document</td>
<td>x</td>
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<td></td>
</tr>
<tr>
<td>Clear Roles</td>
<td>Agreed and informed policy guidelines</td>
<td>x</td>
<td></td>
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<td></td>
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</table>
### Absorptive Capacity Framework

<table>
<thead>
<tr>
<th>Absorptive Capacity Framework</th>
<th>Basic elements</th>
<th>Absorptive activities</th>
<th>Yes</th>
<th>In Progress</th>
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</tr>
</thead>
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<td>Intra-cluster knowledge system</td>
<td>Knowledge spillovers</td>
<td>Stakeholders links</td>
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<tr>
<td>Social relations</td>
<td>Collective learning processes</td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td>Extra-cluster knowledge system</td>
<td>Extra-cluster knowledge sources</td>
<td>Linkages to those sources</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface between the external linkages and the intra-cluster knowledge system</td>
<td>Acquiring new knowledge from extra-cluster sources and transferring knowledge to intra-cluster firms</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 13 Singapore’s collaborative and absorptive capacity.**

### 5.3.2. Concluding Remarks

In Singapore, the government’s goal is to integrate the city-state into the global life science market and leap frog towards the performance levels of clusters located in North America and Europe. And A*STAR, as the institution executing this plan in
collaboration with the EDB and experienced researchers, is aiming towards establishing a comprehensive understanding of the relationships within the network and the cluster’s position in a highly competitive life science field. In sum, Singapore is in the process of identifying and facilitating its competitive advantage – especially in hindsight of evolving regions in China and India. As one interviewee sums up, Singapore is competitive, because it is ‘well-placed, very well connected to a sea and land network and language is not a barrier; you have qualified people and a very strong academic and industrial base already’. This locational benefit is paired with a second-mover advantage and the strong commitment by government (Wong 2011). Another competitive feature that several interview partners pointed out includes the fact that government ‘works like a business’, ‘gets things done’ and ‘does what it promises’. In fact, some government agencies mirror company organization and civil servants have the same professional background as decision-makers in firms. ‘Thus the bonds are social as well as form within the public-private sector alliance’ (Kumar & Siddique 2010, 30). Singapore further offers a secure, English-speaking environment and research facilities carry all the Asian phenotypes companies need to test their drugs while offering a Western-style working environment.

However, as A*STAR notes itself, Singapore is still in the early stages of commercializing and has yet to develop a break-through drug. Also, ‘the current technology-push approach is not sufficient to attract increased adoption rates from small and medium enterprises (SMEs) and MNCs’ (A*STAR 2011, 62). This is reflected in the current innovation rankings. Singapore has been ranked the most innovative country in Asia last year (2012). It was also placed first for its innovation capabilities, based on a well-trained workforce, a robust research community and sophisticated financial markets. Globally, Singapore ranked just below the European nations of Switzerland and Sweden in the 2012 Global Innovation Index. But, while Singapore has done well in terms of innovation input, output results place the country 83rd worldwide. In general, firms have not located their R&D operations in Singapore at the pace and scope as originally envisioned by government. Another mitigating factor is the temporal uncertainty connected to the life science field. As Wong (2011) points out ‘people there are becoming frustrated with the slow pace of commercial growth and some are beginning to reason, understandably, that biotechnology is not worth the patience and
investment, especially given other, less uncertain technology industries in which to invest' (Ibid, 174). In order to reduce some of the slowed relocation and investment connected to uncertainty, the government manufactures ‘stars’ by overinvesting into certain endeavors. Some would classify the new Biopolis buildings as such an overinvestment, as especially local firms are reluctant to move in and networking among tenants is rather limited. Meanwhile, government aims to maintain an appetite by foreign investors and local businesses for the industry (Wong 2011). As for the role of A*STAR as a cluster manager, the Singapore model differs from the North American and Western cases. As Yeung (2010) points out, many of the Asian regions do not develop the kind of institutional thickness (Amin & Thrift 1994) and innovation systems like regions in Europe or North America. In the attempt to change this, Singapore developed a mix of institutions and programs, which made navigating the life science field rather complex. Today, there are efforts to simplify the system – at least for incoming investors and firms. A*STAR, EDB and Ministry of Health (MoH) have recently set up the Singapore Biomedical Sciences Industry Partnership Office (IPO) to serve as a ‘one-stop’ coordination office for MNCs seeking collaborations and investment opportunities (RIE Secretariat 2011). In this, A*STAR combines several functions under one roof by being a government branch, host to key research institutes and facilitator to the overall cluster in terms of managerial guidance and funding at the same time.

The general cluster set-up is coherent and well connected, due to established relationships and trust among stakeholders. However, this tight-knit community only includes some individuals and might hamper outside companies from securing government funding or connecting to other stakeholders (Finegold, Wong & Cheah 2004). Further, if A*STAR struggles in one or more of its roles as government agency, research coordinator or facilitator, there is the danger of a disconnect with network members. The challenge for A*STAR will be, to remain true to the role as an advocate for the whole network. Some of the interviewees closer to the basic research side of the biomedical field, already see A*STAR as being too applied and heavily pushing the commercial side of research.

Overall, the portrayal of openness in Singapore is an example for the processes of knowledge creation and external knowledge absorption co-evolving over time and nurturing each other according to a mutually reinforcing mechanism (Belussi &
This means that Singapore was able to link local knowledge with the incoming experience of MNCs and star scientists in order to move up the value chain from manufacturing to R&D. A*STAR as an umbrella organization taking on different roles in the network is situated at the core of the developing cluster, but is currently not in the position to be a manager similar to, for example, the Medicon Valley Alliance. The weight of the government component in the triple-helix structure is overbearing dynamics between stakeholders in independent research facilities and companies. This top-down model does provide elements of collaborative and absorptive capacity, especially in terms of creating a strategic vision, purpose and setting the cluster up to have close ties to other networks. Wong (2011) predicts that this centralized model of government will eventually diminish as Singapore becomes ‘less developmental’. This means that after the heavy public investment into biotechnology, the political pressure is mounting. The ruling PAP government’s legitimacy is linked to economic performance and with uncertain success, a retreat of the state might be in Singapore’s future. The weaknesses of the current model further extend to the lack of informal communication and networking on the ground, as most links are generated or facilitated from government-side. Finally, the case suggests that far-sighted public policy plans only work with the according scientific manpower base and business capabilities (Finegold, Wong & Cheah 2004). Currently, there is a lack of attention paid towards fostering the development of local biotechnology start-ups and more generally, the generation of informal ties among stakeholders.

**Facilitator model**

Overall, the facilitator model in Singapore is different from Medicon Valley and Chicago in the sense that the network management responsibility lies with government. A*STAR is a government department and reports to the Ministry of Trade and Industry. Because the facilitator is part of government, Singapore took a very pro-active approach towards engaging industry and establishing itself as the channel to gain access to government funding and larger developments in the life science sector. The advantages of this approach are obvious: By being part of government, the facilitator can develop coherent funding programs and gaps in the cluster can be met with policy initiatives more quickly. The facilitator is further able to coordinate physical space with cluster needs, such as creating a science park close to university, as done with the space at
Biopolis. A*STAR further created trusting relationships to stakeholders by having the same tandem leadership over many years. This means network members would deal with the same people and built relationships with the department in that way. A*STAR can further tap into a wide network of well-known CEOs and scientists through their own or other government employees. This makes them credible when talking to stakeholders. The Singaporean facilitator model also has a learning component. Potential knowledge about how to set up the cluster is brought in by foreign investors that train and educate people in Singapore and also often act as consultants for government on how to proceed.

However, there are also disadvantages to this approach. The closeness to government also harms the image of the facilitator, because the manager is not seen as independent but rather acting in favour of government plans. This can limit the reach of the manager in terms of industry connections. This might not apply to Singapore in particular because government is run business-like and many relationships to multinationals have been established through officials, but it is a point that has to be considered when transferring the model to another country. Also, the Singaporean model of facilitation is described as ‘overbearing’ by stakeholders outside of the immediate government network. This implies that entering the cluster and being able to establish informal relationships is more difficult.

5.4. Vancouver (British Columbia, Canada)

Compared to Chicago, Medicon Valley and Singapore, the Vancouver life science network is facing challenges that can be attributed to not having cluster management and the lack of absorptive and collaborative capacity following from that.

The cluster is ‘dominated by firms in the healthcare sector, [and] is home to about 90 privately owned firms, as well as six clinical trial organizations, a handful of government facilities and a major research centre at the University of British Columbia’ (Bogomolny et al. 2004). The BC government heavily invested into R&D with more than $1.6 billion in expenditures since 2001. The Canadian government is providing $60 million in funding for new centres of excellence in commercialization and research alone
(Vancouver Economic Commission 2011). On top of that, BC committed to a Western Economic Partnership Agreement (WEPA) with the federal government, in which both governments contribute $25 million to WEPA over four years (2009-2013) to support long-term economic growth and competitiveness in BC. This includes strengthening knowledge-based businesses and technological innovation.

However, in this process, the network became very dependent on one firm, QLT Inc., which generated 87% of the cluster’s revenue before it declined – without forming strong relationships among stakeholders or creating a management system for the network (Gertler & Quach 2005). Today, there is little horizontal integration and even less vertical integration (Holbrook et al. 2003). On top of these obstacles to innovation, Vancouver struggles to find and retain qualified employees, due to substantial competition from US and Eastern Canada – primarily based on high personal income taxes and housing costs (Holbrook et al. 2003). Stakeholders are also facing the lack of ‘robustness to failure’. This means that the risk of joining a biotechnology firm that might eventually fail is not off-set by other job opportunities in the network (Casper 2007). Finally, Vancouver has become a hub for IP ‘vendors’, which means that firms do not manufacture or market a product in the region, but rather sell intellectual property to larger multinational companies that are housed in the US (Gertler & Quach 2005; Holbrook et al. 2003). The attraction of the US market is partly based on the greater specialization of the American manufacturing sector in higher-technology, R&D intensive industries than it is the case for Canada. This structural condition further ‘accounts for many of the issues that continue to confound the innovation policy dialogue in Canada, e.g., the relatively weak demand for graduates with advanced degrees in science and engineering, and the particular difficulty of connecting university research with business’ (CCA 2013, 7).

As the following analysis will show, these issues are directly related to the levels of collaborative and absorptive capacity.
5.4.1. **Collaborative and absorptive capacity**

**Collaborative capacity**

In Vancouver, the biotechnology sector is currently missing a *purpose*, although it is something which is desired by stakeholders. The interviewees agreed upon the fact that there is no common goal or strategy for biotechnology in the province. They argued that this is due to several factors, but mainly because the life sciences sector is split into smaller groups, none of which is big enough to actually drive the agenda of the industry and lobby public office holders. In 1991, the establishment of the BC Biotech Alliance Society (now LifeSciences BC) was an attempt to unite industry players. The industry-led and membership-driven organization is committed to connecting and representing life science stakeholders. Their mission statements reads:

*We...represent the industry to key government decision-makers, aggressively promote the sector by showcasing BC’s biotech sector nationally and internationally, and create networking and collaborative opportunities both within the community and with external groups key to the success of BC’s biotech companies.* (BC Biotech 2005, 5)

In this sense, LifeSciences BC is a steward of industry partnerships. By unifying at least some of the biotech stakeholders, LifeSciences BC facilitates collaboration among them as well as devotes resources to managing the image of the sector (Ansell & Gash 2012). The organization also lowers transaction costs for single firms and serves as an umbrella organization for smaller entities in the network. For researchers, Genome BC\(^5\) is a ‘node’ in the network. The non-profit organization unites stakeholders based on individual projects, but only those that focus on genomics – a small part of life sciences. So far, both organizations have not been able to overcome sector fragmentation. In response to this, several interviewees expressed the need for government to step in. In connection to the socialized healthcare system in Canada, some stakeholders see government in the responsibility to come up with a framework. As one industry representative put it:

\(^5\) Genome British Columbia is a non-profit research organization that invests in and manages large-scale genomics and proteomics research projects and enabling technologies focused on areas of strategic importance such as human health, forestry, fisheries, bioenergy, mining, agriculture and the environment (Genome BC 2013).
Government should not fund life sciences. Government should come up with – and I keep coming back to this – this idea of some sort of industrial strategy that they are going to focus on. (Life science industry organization interviewee, April 2012)

In order to create some sense of purpose and direction, industry, research and government need to agree on the direction of life sciences. But especially in the area of healthcare, industry and government interests often involve trade-offs, such as profit maximization versus risk minimization. As one interviewee put it: ‘particularly in life sciences, it is a political hot potato right now, no one wants to touch healthcare and yet we are going to have 60 percent of our expenditure going towards healthcare’. Government is focused on cost control, while industry and research is looking for innovative ways to move forward. As communication is running in opposite directions, according to interviewees, a provincial industry strategy could help to create purpose and at the same time create a common ground for agreeing upon future goals.

Additional disadvantages connected to the healthcare focus include the large number of stakeholders involved in the sector and the challenge of bringing them together. Some of those actors might have the potential to impact the cluster, but remain in the background, because they are not visibly connected to any central organization. They might not be part of the LifeSciences BC umbrella, because they cannot afford the membership or simply do not want to participate. The consequences of the inability to identify key players in the network are that it is even harder to form relationships among all network members or create communication channels. On top of that, in a socialized medicine system, there is little incentive to create a working structure or rather improve the existing one. Government is reluctant to make significant changes, because healthcare is a politically charged topic with a pattern of costs and benefits to providers, consumers and funders which are difficult to alter. And from an industry perspective, it is mostly inaccessible. BC has a provincial legislation that reinforces the Canadian Health Act which includes provisions forbidding extra billing for facilities or materials and a cap on what can be charged for services by doctors who opt out. Thus, the healthcare system is trapped in a series of segregated budget functions. LifeSciences BC sums up the problem from an industry perspective the following way:

The development of British Columbia’s biopharmaceutical, medical device industry and all related academic and industrial institutions who
feed the life science industry, are directly and negatively impacted by our present healthcare system, and in particular, by BC’s Pharmacare policies. We believe there is a better way forward – one that recognizes the interests and value of industry while advancing the public interest and delivering appropriate patient outcomes. (LifeSciences BC 2007, 4)

On the positive side, the healthcare system offers an existing infrastructure and network based on the single-payer system. A database of individuals for providers and firms in the sector is in place, which could potentially be extended based on genomics components and other innovative aspects. This would also facilitate post-marketing and surveillance studies. Combining these obstacles and opportunities it seems that both industry and government could find a common path to pursue life sciences innovations in healthcare. This means that government being in charge of healthcare-related issues has to work with industry associations like LifeSciences BC for them to start pulling together the multitudes of smaller clusters that currently exist in the sector and make a coherent structure possible which would facilitate development of a unified purpose and its communication.

To establish a common ground on this issue, communication is crucial. Communication in general and communication channels in particular ensure information transmission in a cluster and also put information in the context of solution-seeking (Lai 2011). The biotechnology sector in British Columbia has some informal linkages and communication mechanisms, but no formal structure. Both, LifeSciences BC and Genome BC have procedures in place to communicate within their organizations and among each other. For example, each board has a member of the other organization present and involved in discussions. Further, Genome BC interviewees highlighted the following cooperation mechanisms:

- sector consultations;
- taskforce networks; and
- connections developed by research project managers.

Sector consultations are industry-led taskforces, including champions and decision-makers, experts in the field, industry, government and academia that come together occasionally and identify research priorities and current challenges. Also, they emphasize possible areas in which genomics could address those challenges and make
the network competitive. This involves a lot of dialogue and consultation to outline which activities would be useful in the future.

The second communication mechanism, the taskforces, was a one-time initiative led by industry. They were formally set-up in 2006 and ran for about two years. The taskforces gave advice on how to design a research program and where investments should be made. Although they have not been formally active since then, the same individuals or same groups of end-users, industry and others are now directly involved in Genome BC projects either as co-funders, advisors or researchers. They provide materials or locations for research. Those participants are also often the people that are called when a new project is launched in order to get ideas on how to collaborate and which stakeholders to involve.

The third mechanism within Genome BC is the existence of a research project managers’ (RPMs) network. RPMs are crucial to the development and realization of research projects, because they get to know their six to twelve projects very well and are able to communicate with key stakeholders in the field. RPMs also draw together a specific group of researchers for each project, which are able to exchange knowledge from the science to the social science side and back. Thus, project managers are able to foster knowledge transfer not only within one specific group, but also beyond disciplinary boundaries. One example of this dynamic is a Genome BC water project where RPMs were able to add expertise for starting a scientific team, which got national recognition. In this role, RPMs can be seen as having a catalyst position in the network by going beyond the organizer or administrative role and engaging in the substantive content of negotiations with the goal of ‘identifying and exploiting opportunities for productivity value’ (Ansell & Gash 2012). They bridge the work of different stakeholders and disciplines through communicating who has the expertise and which people should connect to create a successful new research project.

Such sources of information and the right combination of high-skilled labour is one key to higher innovation performance, even on a small scale or in one sector (Dossou-Yovo & Tremblay 2012). As some interviewees pointed out, these small-scale cooperation mechanisms could serve as an example for the whole network to set-up communication channels.
In terms of *structural elements* that would allow collaborators to be flexible and adaptable in their development (Lai 2011), BC’s increasingly accessible project funding structure and the role of Industry Technology Advisors (ITAs) in the Industrial Research Assistance Program (IRAP) contribute to the prospect of a successful transition. The latter program is one cornerstone of the BC innovation policy and offers assistance to SMEs. It further provides advisory services through ITAs and funding support for high-risk R&D projects. IRAP also supports non-profit and post-secondary institutions for the provision of technical and commercialization advice to SMEs. Thus it creates an informal structure for knowledge transfer, consultation and advice within networks. And although IRAP generally seems to be a successful program, it falls short in supporting BC on a larger scale. The main criticism is that it not only disappears between other programs due to its size, but its funds are also exhausted early in the fiscal year. Smaller firms complain about the excessively difficult first-time applications process and the length of time between application and a decision (Jenkins et al. 2011). In connection to the aspect of accessibility, some point out that the BC R&D ecosystem has become more open. As one interviewee put it: ‘there is a lot more acceptance of the fact that you can access other programs in terms of funding, to get work done in academics or vice versa.’ Thus, programs are becoming less rigid in their definition of where the funding is coming from and who participates, which makes inter-agency cooperation easier.

Obstacles to building a network *structure* include current Intellectual Property (IP) Rights and university-industry relationships. In terms of IP protection, Lybecker (2012) points out that

Canada ought to implement patent term restoration, which would provide innovative pharmaceutical firms up to five years of additional product exclusivity to compensate for the lengthy regulatory approval process as well as extended data protection for the data from the clinical trials of brand name pharmaceutical companies. (Lybecker 2012)

In sum, Canadian IP regulation is not on par with other innovation-intensive nations. In contrast to the United States and the European Union, for example, Canada does not provide an extra period of patent protection as compensation for time lost during regulatory approval delays. And because pharmaceutical industries rely so heavily on patents, the life science industry is especially dependent on an enhanced
legal environment to create profit and investments (Lybecker 2012). Further, some life sciences companies are reluctant to work with universities, due to the uncertainty of academic programs being able to support long-term large-scale projects and adjust to the rapid pace of research. So in order to create some kind of structure that enables such linkages, those issues have to be addressed. This line of thought leads back to the importance of communication in both the development of a purpose and successful network re-structuring – if each side does not articulate the issues successfully, a structural framework can hardly be set up. The successful government component of IRAP also shows that there need to be agreed and informed policy guidelines not only regarding contents and goals of BC biotechnology, but also structural elements for communication and cooperation. Overcoming these problems, in turn, is related to the availability of resources regarding biotechnology work.

Resources in this case not only include financial means, but also intellectual and human capital to develop and sustain collaborative efforts (Lai 2011). In any network, most stakeholders have some form of interactive dependency, usually based on the exchange of these resources (Pennings 1981). They affect the ability to communicate and develop the structure and purposes required for successful cluster-based commercialization activities.

In the BC biotech network, stakeholders struggle with the way government provides some of the resources and also with the lack of opportunities to attract human capital. There is a variety of governmental support, but not all of it is effective. Genome BC, for example, is a major investor focused on the tools of genomics for biotechnology. About 25 percent of the funding for Genome BC comes from the province and about 50 percent from the federal government. However, genomics is only a small part or tool of an increasingly broad spectrum of life sciences. And second, government-funded programs are subject to restrictions: For example, the funding has to stay in BC and includes a cap on how much one project can receive. The funding regulations sometimes even specify program participants. This results in programs that are mostly not tailored towards industry needs.

Interviewees added the following government resources, which are not channeled through Genome BC or Genome Canada:
- National Research Council Industrial Research Program (NRC IRAP);
- Natural Sciences and Engineering Research Council (NSERC);
- Centre for Drug Research and Development (CDRD);
- Institutional Programs Office;
- Technology Transfer Offices (TTOs).

Technology Transfer Offices are the primary point of contact for companies and other entities that wish to acquire technologies and make use of resources of the government-led Communications Research Centre. For BC, technology transfer is an opportunity for small- and medium-sized enterprises to establish IP through CRC’s laboratory infrastructure. Those offices also support successful cooperation between firms through intermediation (Brenner et al. 2011). They are largely government-financed. UBC’s University-Industry Liaison Office (UILO), for example, is supported by the British Columbia Innovation Council (BCIC), which is a Crown Agency of the Province of British Columbia. At Simon Fraser University, the Innovation Office (IO) receives ongoing support for its activities and programs from the IDC program of the federal granting councils. The Ministry of Advanced Education, Government of British Columbia also offer operational support through BCIC. The IO further receives project and program support from Western Economic Diversification Canada and the IRAP program of the National Research Council.

The Institutional Programs Office provides administrative and strategic support to researchers pursuing major federal, provincial and regional infrastructure awards. In BC these awards are offered by the British Columbia Knowledge Development Fund (BCKDF) and regionally by Western Diversification Canada (WD). For the provincial research community, such as the University of British Columbia, the office provides services, such as internal reviews of funding applications, post-award workshops, financial and strategic support. Overall BCKDF and WD provide infrastructural and financial support for pre-commercial things with academic institutions doing community-based events related to economic development. This is different to what the Industrial Research Assistance Program does, which funds individual small- and medium-sized enterprises. But IRAP does not necessarily link up to universities and rather focuses predominantly on the industry-side of the biotechnology network.

The CDRD is a national not-for-profit public-private organization headquartered in Vancouver, which provides drug development expertise and infrastructure to enable
researchers from leading academic and health research institutions to advance promising, early-stage drug candidates. Genome BC works closely with CDRD due to their platform of drug discovery and antibody development for drugs.

Finally, the National Sciences and Engineering Research Council (NSERC) supports university students in their advanced studies, promotes and supports discovery research and facilitates innovation by encouraging Canadian companies to participate and invest in post-secondary research projects. Thus, NSERC uses federal funding to support collaborations between industry and academia. This funding is located at the national level, which means the amount allotted to BC varies. On top of that, there is the scientific research and experimental development tax credit, which is not tied to one sector and supports business R&D spending of various kinds.

From this selection of government programs it becomes clear that there is a complex mix of resources existing at the national, provincial and regional level. This also poses a challenge to stakeholders, as

there is...a need for coordination across the full suite of federal innovation programs – and ideally also between programs of the federal and provincial government – to avoid excessive ‘stacking’ of incentives that may result in subsidies that are higher than needed to achieve policy objectives. (Jenkins et al. 2011, 42)

For BC firms, finding the right program and calculating potential support has become more and more difficult and some suggest that the development of an online platform on which all funding programs are listed or even a ‘match-making’ service for firm and funding would be a good solution.

The remaining question is how adaptive is the cluster to internal and external changes and – not always favourable – circumstances? Does it have the tools to prevent the network from falling apart and create connections inside and outside of the cluster?

**Absorptive capacity**

In terms of outside connections and valuable links, Vancouver is at a disadvantage due to its geographic location. It has a large population, but limited development opportunities for an ‘inland hinterland’ (O’Connor & Scott 1992). This
makes Vancouver dependent on its transportation and communication links. At the same time, the city is a ‘pivot point’ between North America and Asia, which is an advantage to other high-tech clusters in Canada and the US. However, ‘its major continental competition is in California, which has similar geographical attributes’ (Wixted & Holbrook 2011, 21). This means that in the immediate area, Vancouver is missing a critical mass of other networks to connect to, especially when they are located further south. This would make a strong connection to the Asian market even more important.

But, as the Singapore case study has shown, they have been successful in employing scientists of their own from North America and made themselves attractive for foreign researchers. Hence, the location could be a barrier to Vancouver’s development beyond a certain size (Wixted & Holbrook 2011). In terms of absorptive capacity, there is not much of an inter- or extra-cluster knowledge system, due to the weak links within the cluster and the low critical mass and distance from mega-regions for outside ties. Again, a cluster facilitator would pose as the missing link between outside-acquired knowledge and making it useful within the cluster as well as cultivating relationships to other networks, as seen in the Oresund Region, Chicago and Singapore.

Using the concepts of collaborative and absorptive capacity the results presented here show that the BC cluster is lacking most of the key elements of successful cluster-based commercialization activity (see Table 14). Stakeholders generally are aware of the strengths and weaknesses of the cluster, but are also disenchanted by the facts. As shown throughout the case, the BC cluster has a strong research component and there are informal and ad hoc cooperation mechanisms and resources in place, but with a largely informal structure and little purpose or communicative activity.

As Hutton (1998) points out, Vancouver profits from the immigrants coming from Asia, as they include large proportions of individuals in the ‘investor’ and ‘entrepreneur’ category, as well as large contingents with strong entrepreneurial skills and trading traditions (Ibid, 85). However, the impacts of the amount of that immigration shifted Vancouver’s focus towards social planning, ‘adopting regulatory rather than developmental policy approaches and giving less priority to economic policies and programmes’ (Ibid, 97). This implies that Vancouver needs to be more active in finding a strategic niche in the Asia-Pacific.
<table>
<thead>
<tr>
<th><strong>Collaborative Capacity Framework</strong></th>
<th>Basic elements</th>
<th>Collaborative activities</th>
<th>Yes</th>
<th>In Progress</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Leadership</td>
<td>Identification of leadership role</td>
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</tr>
<tr>
<td></td>
<td>Shared Vision</td>
<td>Mission statement/agreement</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Network membership</td>
<td>Connection to a broader functional network</td>
<td></td>
<td>x</td>
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<tr>
<td><strong>Structure</strong></td>
<td>Formal and Informal Procedures</td>
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<td>Clear Roles</td>
<td>Agreed and informed policy guidelines</td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td><strong>Communication</strong></td>
<td>Information Links</td>
<td>Formal agreements/personal connections</td>
<td>x</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Active Communication</td>
<td>Communication technology, e.g. boundary-free information platform</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resources</strong></td>
<td>Knowledge and Skills</td>
<td>Knowledge-based modes using techniques such as pre-planning, role plays, on-job training, drills and exercises, and simulation for collaborating managers</td>
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<td></td>
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<tr>
<td></td>
<td>Financing Powers</td>
<td>Collective financial pool</td>
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<td>x</td>
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</table>

<table>
<thead>
<tr>
<th><strong>Absorptive Capacity Framework</strong></th>
<th>Basic elements</th>
<th>Absorptive activities</th>
<th>Yes</th>
<th>In Progress</th>
<th>No</th>
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</thead>
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<tr>
<td><strong>Intra-cluster knowledge system</strong></td>
<td>Knowledge spillovers</td>
<td>Stakeholders links</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Social relations</td>
<td>Collective learning processes</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Extra-cluster knowledge system</strong></td>
<td>Extra-cluster knowledge sources</td>
<td>Linkages to those sources</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interface between the external linkages and the intra-cluster knowledge system</td>
<td>Acquiring new knowledge from extra-cluster sources and transferring knowledge to intra-cluster firms</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Table 14** Vancouver's collaborative and absorptive capacity. |
5.4.2. **Concluding Remarks**

Based on the analysis above, BC life science stakeholders would profit from building a strong network. Many capabilities in the research field currently remain untapped, due to the weak linkages between academia, industry and government. Some of the disadvantages, such as the geographic positioning of Vancouver or the funding schemes can be off-set by gaining value through collective links (Raines 2003). This means the goal of the BC biotechnology cluster should be to maximise the value of networking possibilities. Given the limitations of private sector involvement cited above, this is tied to the policy approach taken by governments. For the provincial and federal government it is not enough anymore to just support the university and research structure in BC. They have to further target the behaviour and networking within and the performance of the whole cluster. This is also supported by a Council of Canadian Academies Report (2013), which points out that in the years to come, Canadian companies will develop strategies that focus on innovation and that firms will create a much more powerful ‘business-pull’. In light of these developments, governments ‘must continue to provide the support needed to sustain Canada’s research excellence as the demand for leading-edge skills and ideas rises to meet the supply’ (Ibid, 31). Further, enhancing coherence within the cluster in terms of purpose, communication and structure could go a long way for the competitiveness of the life sciences research in BC. Especially health-related life science is mobile and moves to where the money or human capital is. This means the most important competitive advantage in all of this for BC is the quality of the network itself and the management of networking processes for furthering life sciences is critical in this.
6. Analysis: Facilitators as effective mechanisms for cluster support?

6.1. Cross-case Summary

The four cases display variations of the cluster management model in tandem with the level of government involvement in each country. In Vancouver, there is no visible management structure. While LifeScience BC has a leadership function for industry stakeholders, there is no institution linking it to government or research. Genome BC has close ties to officials based on its funding structure, but only covers a small portion of research involved in life sciences. Following from this, it is difficult to create a common vision for the cluster or to communicate the needs of each group. In Singapore, network creation and development is government-driven – even the cluster management organization, A*STAR is part of government. This set-up is, for the most part, structured in a top-down manner while cooperation among stakeholders is rather weak. Thus, the cluster management tool currently does not have a strong basis of network member relationships. It remains to be seen if those connections will grow over time or if government is one step ahead of what is actually happening from the bottom-up. In Illinois, government created a separate office, the Office of Entrepreneurship, Innovation and Technology, which works closely with iBIO. In this case, government has less direct involvement in the networking dynamics of the cluster and rather complements the work that is done on the ground by the industry organization. It still, however, provides strategic goals by, among other things, focusing on firm creation. According to Hakanson (2005) this is one of the crucial motors for cluster development, as not the survival rate of firms is an indicator for stakeholders of how likely it is that firms are formed and financed, but their creation. This is paired with the opportunity structure of the overall cluster in terms of funding and alternative employment. The mentoring, training and shared facilities programs by government also hints towards a common strategy of entrepreneurial support and networking among university
researchers, start-ups and companies – focusing on the development chain from research to industry. However, to become a major player in the life science field in the US and beyond, Illinois – in partnership with the eight other states – has to show that this development is sustainable and backed-up by continued funding and support. Illinois has the momentum right now to establish lasting networking structures that boost collaborative and absorptive capacities. The Medicon Valley case portrays government involvement in a multi-level system environment where the Medicon Valley Alliance deals with the networking on the ground and connects government levels. The cluster has seen an increase in regional projects at the national levels and consultation processes of locals stakeholders by government through the MVA channel. Based on this, the role of the Alliance can be described as crosscutting multiple levels, facilitating connections among them as well as integrating ‘local buzz’ and ‘global pipelines’ (Wolfe & Creutzberg 2003).

Overall, the cases align along a continuum from strong (Medicon Valley) to no cluster management (Vancouver). The variation of the management model shows that there is not one way to manage a cluster and the role of government differs. Often the model adopted is based on the existing structures that emerged from earlier industries. Further, government action is restricted by the political system and power constellation – depending on the jurisdiction and funding opportunities. However, the facilitation process in all three cases that had cluster management, portrays some common characteristics, which include:

(1) those that deal directly with cluster stakeholders are knowledgeable in the life science field;
(2) there is always a connection between government, research and industry (triple-helix);
(3) an organization by or at arm’s length of government is managing the cluster;
(4) each facilitation incorporates a learning component; and
(5) at one point in time there was a conscious decision made to focus on biotech/ life sciences.

Also, collaborative and absorptive capacities were visibly connected to the cluster manager, as the facilitator provided, among other things, the strategy,
communication channels or connections to other clusters, stakeholders saw growing momentum in networking, funding and retaining capital.

It is important to note that none of these clusters emerged suddenly. All of them rely on substantial research facilities and existing universities. However, there are more world class universities than biotechnology clusters and many regions have not developed sizable life science networks (Casper 2007). Those that have been successful were further able to build on existing structures formed by previous industries. As Feldman & Florida (1994) point out, the ‘capacity to innovate is very much the historical legacy of specialized concentrations of R&D, industrial activity, and support services that build up in particular places over time’ (226). Even if the previous industry was completely unrelated to biotechnology or even high-tech in general, every innovation depends on a set of underlying factors that comprise a technological infrastructure for generating new ideas and bringing them to the market. The Midwest, for example, has a history of manufacturing infrastructure in steel, automotive, appliance and consumer durable production, which paved the way for today’s biotech developments (Feldman & Florida 1994). Singapore was open to foreign investors early-on, as the government actively promoted bilateral free trade agreements (FTAs) in order to maintain locational attractiveness in the regional production networks. This led world class electronics companies such as Hewlett-Packard, Philips or Toshiba to locate their high-value activities to Singapore (Yeung 2010). Thus, the city-state already had an infrastructure for hosting R&D and manufacturing facilities. In the late 1990s, following the same strategy of cluster development previously applied to electronics and chemicals, Singapore developed the Tuas Biomedical Park a 183-hectare world-class manufacturing hub, which attracted names such as MSD, Novartis and GlaxoSmithKline Biologicals (Medrisch 2008). In fact, ‘Singapore’s first foray into the biomedical sciences sector was through the establishment of the Institute of Molecular and Cellular Biology (IMCB) in 1987 at the National University of Singapore’ and other research institutes followed in the years between 1996-2000, including the Bioinformatics Center, the Genome Institute of Singapore, the Bioprocessing Technology Centre and the Institute of Bioengineering and Nanotechnology (Finegold, Wong & Cheah 2004, 922). This does not take away from the importance of cluster management, but rather emphasizes the
importance of the pre-conditions for the success of a network in connection with facilitation.

Three of the clusters, Singapore, Chicago and Vancouver, struggle with the lack of knowledge spill-over opportunities in connection to location. Due to their geography, these cases are at a disadvantage compared to Boston, San Diego or even Medicon Valley. They lie further away from other research hubs and have more difficulties connecting to such. Singapore has partly solved this problem by ‘importing’ this knowledge through the MNCs and absorbing as much of the foreign experiences as possible. Chicago or rather Illinois, on the other hand, has now laid out plans to collaborate closer with its neighbouring states. This is an issue that is mostly tackled by cluster management in cooperation with government, which is a reason for the fact that Vancouver was so far unable to tap into the evolving life science hub in Seattle and into connections with Asia.

6.1.1. Performance

A comparison of these cases based on performance data is difficult, due to the fact that the cluster idea is not only ahead of many conceptual and theoretical concepts, but also often does not fit with the way data is gathered (Martin & Sunley 2003). The numbers available provide information for different levels – country, region, metropolitan area – and at different times, but seldom for a specific cluster. This is has to do with the fact that data at regional or metropolitan level in a particular technology area is often subject to confidentiality rules that limit their availability (Davis et al. 2006). Also, there are multiple definitions of biotechnology or life sciences, which affects the data-gathering process. Overall, ‘while many different methods and techniques for analyzing clusters have been proposed in the literature (see for example, Padmore and Gibson 1998), no standardized approach has emerged, and numerous challenges have been identified’ (Davis et al. 2006, 4).

Summarizing the most recent attempts to streamline the data-gathering process, the European Union and PricewaterhouseCoopers, for example, have made efforts to specify better measurements for clusters. This renewed interest, at least in Europe, stems from the fact that countries like Hungary, Germany and Sweden ‘appear to
consider the quality of cluster organizations as a key indicator of future cluster performance’ (Köcker & Rosted 2010, 15). European plans include data gathering processes through the combination of self-reporting surveys with ‘hard’ data. In turn evaluation is then used to adjust regional cluster activities and national government services to clusters. Another recent EU project\(^5\) used three inter-connected indicators: employment, average real wages and innovation. Information was further collected on current framework conditions, such as access to human capital, availability of knowledge, entrepreneurial activities, quality of public regulation and the degree of collaboration. In comparison, an industry study by PriceWaterhouseCoopers (2011) on performance measures for biotechnology focuses on data available through various scoreboards from, for example, OECD or the US Census Bureau. The report suggests looking at three general categories, including employment, innovation and productivity. Each indicator possibly consists of multiple variables, such as total employment, employment growth, number of improved products, services or technologies and wages.

In this study, the framework of collaborative and absorptive capacity captures the conditions of the cluster that affect its performance. The following indicators used, roughly relate to the indicators suggested by the European Commission and various industry reports and to the capacity levels. Based on this, Table 15 includes the share of patents in the cluster or metropolitan area, the number of biotechnology-related employment opportunities, R&D expenditure, the unemployment rate and the average income. The employment data, the number of jobs and the unemployment rate, give an indication of the attractiveness of the region overall and the opportunities to find jobs. Employment is also related to the ‘robustness of failure’, which means that the risk of joining a biotechnology firm that might eventually fail is off-set by other job opportunities in the network (Casper 2007). A high number of employments also is a proxy for the number of firms, which allows to make conclusions about the number of spin-offs and MNCs. The share of patents and R&D expenditure are proxies for the innovation potential in the cluster. The average income is not only an indicator for the attractiveness of the region, but high wages also suggest that the network compares in the competition

\(^5\) Baltic Sea Region InnoNet project, initiated by DG Enterprise and the European Commission, is intended to establish a possible link between cluster performance and cluster specific framework conditions.
for human capital. The numbers do track a general trend of the four clusters and give insight how they rank globally, however the data has to be treated with caution due to the reasons mentioned in section 3.1.2.

San Diego and Boston are still at the top in terms of life science clustering. In the data presentation (Table 15), Boston is therefore used as a reference point for what is possible in other networks and highlights the goal most clusters are trying to achieve. However, compared to Boston, Singapore, Chicago, Medicon Valley and Vancouver are all emerging clusters, hence the gap between the numbers remains rather large. This also has to do with the fact that the current biotechnology market features a ‘winner-takes-all’ model when it comes to, for example, venture capital investments. In fact, leading clusters in the US take away most the investment and the positive results following from it. Across the US, Europe and Canada, biotech companies raised $25 billion US dollar in 2010 alone, however US companies received 82.6% of that capital. The financial crisis has also affected the have-nots more than the already successful clusters, furthering the gap between clusters such as San Diego or Boston to, for example, Chicago (Ernst & Young 2011).

Table 15 lists the cases according to the order they appeared in the previous chapter.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Cluster</th>
<th>Cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of patents filed</td>
<td>Boston-Worcester-Manchester</td>
<td>5.2%</td>
</tr>
<tr>
<td>Copenhagen54</td>
<td>Copenhagen54</td>
<td>1.7%</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan-City</td>
<td>Chicago-Naperville-Michigan-City</td>
<td>0.90%</td>
</tr>
<tr>
<td>Singapore</td>
<td>Singapore</td>
<td>0.70%</td>
</tr>
<tr>
<td>British Columbia55</td>
<td>British Columbia55</td>
<td>0.18%</td>
</tr>
<tr>
<td>No. of biotech-related jobs</td>
<td>Boston</td>
<td>74,000 jobs</td>
</tr>
<tr>
<td>Medicon Valley</td>
<td>Medicon Valley</td>
<td>between 35,000 and 41,000 jobs</td>
</tr>
</tbody>
</table>

54 Hovedstadsregionen, the region of Copenhagen, contributes 86% of PCT biotechnology patent applications by Danish residents and to 1.7% of total biotechnology patents (OECD 2009b).
55 Triadic Patent Families for technology sectors Per Million Population.
Table 15 Case comparison

The table shows that, as predicted, compared to Boston, all cases are still catching up to the level of performance. For Medicon Valley, the data gathering process revealed that it is difficult for people outside of the cluster and also stakeholders in the cluster to properly evaluate some of the performance measures, because the numbers

56 Danish Part 8% / Swedish part 9% [first quarter of 2012]

are often only available separately for Denmark and Sweden or with a focus on
metropolitan areas, such as Copenhagen. This might result in a distorted image of the
region, as Sweden is strong in R&D-related activities, and Denmark, and Copenhagen
especially, perform well in firm-related action, such as patent-filing. Some even feel that
the connection between the two in the Oresund Region is not always an advantage. As
an OECD report highlights:

In the biotech-pharma sector, Copenhagen and Skåne are said to be
substituting rather than complementary, and some of the research
carried out is redundant (Sornn-Friese and Sorensen 2005). Despite its
leading position in bio-medical research, the Øresund Region could do
even better. (OECD 2009a, 82)

However, the cluster is still an important contributor to the life science field in
both countries, as it accounts for 60 percent of the drug development in all of
Scandinavia (DTZ 2012).

Singapore also has mixed data availability, which has to do, one, with the age of
the cluster, but also with the fact that the government is very aware of its outside
appearance to possible investors and presents its numbers accordingly. There is a
strong focus on the government investment side of the data and the success stories of
attracting MNCs and unique research labs. For the Chicago case, the documents
assessing US clusters revealed that the cluster only shows up in performance ranking
since 2005/2006. Before that Chicago was barely on the radar for life sciences.
Apparently during that time, Chicago was able to put itself on the map and is now
consistently one of the top 20 life science clusters in the US.

Comparing all four clusters, Medicon Valley and Chicago top the list in most of
the categories. They are both strong and further ahead of Singapore and Vancouver in
the number of biotech jobs they provide and the average income. All cases show similar
numbers in the share of patents filed and the rate of R&D expenditure, especially taking
into account that some of the data measures a province (British Columbia) and some a
city or region. Linking the capacity framework to the performance data, the comparison
of all four clusters shows that the two top cases, Medicon Valley and Chicago, also
inherent most of the collaborative and absorptive elements (see Table 16). From the 13
elements specified above, both clusters inherent ten. Vancouver and Singapore are not
as consistent. While Vancouver is missing many of the elements connected to purpose and resources and is working on its absorptive capacity. Singapore does possess ‘purpose’ and has mixed results on the remaining categories.

<table>
<thead>
<tr>
<th>Collaborative Capacity Framework</th>
<th>Basic elements</th>
<th>Yes</th>
<th>In Progress</th>
<th>No</th>
</tr>
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<tr>
<td>Purpose</td>
<td>Leadership</td>
<td>MV</td>
<td>Vancouver</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Shared Vision</td>
<td>MV</td>
<td>Vancouver</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Network membership</td>
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<td>Vancouver</td>
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</tr>
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<td></td>
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<td></td>
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<tr>
<td>Structure</td>
<td>Formal and Informal Procedures</td>
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<td>Chicago</td>
</tr>
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</tr>
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<td>Clear Roles</td>
<td>MV</td>
<td>Vancouver</td>
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<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Information Links</td>
<td>Vancouver</td>
<td></td>
<td>Singapore</td>
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<td>Active Communication</td>
<td>MV</td>
<td>Vancouver</td>
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<td>Resources</td>
<td>Knowledge and Skills</td>
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<td>Singapore</td>
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Intra-cluster knowledge system

<table>
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<tr>
<th>Knowledge spillovers</th>
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<th>Singapore</th>
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</thead>
<tbody>
<tr>
<td>Social relations</td>
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<td>Vancouver Singapore</td>
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</table>

Extra-cluster knowledge system

<table>
<thead>
<tr>
<th>Extra-cluster knowledge sources</th>
<th>MV Chicago Singapore</th>
<th>Vancouver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface between the external linkages and the intra-cluster knowledge system</td>
<td>MV Chicago</td>
<td>Vancouver Singapore</td>
</tr>
</tbody>
</table>

**Table 16 Collaborative and absorptive capacity of all cases in comparison.**

In general, studies suggest that the attention has shifted from looking at the pure numbers towards the way stakeholders are connected in the cluster. In fact, networking and partnerships are at the top of the list of cluster success factors (Peck & Lloyd 2008, see Table 17).

<table>
<thead>
<tr>
<th>Cluster success factors</th>
<th>Approximate percentage identifying each factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Networking &amp; partnership</td>
<td>78</td>
</tr>
<tr>
<td>Innovation technology</td>
<td>75</td>
</tr>
<tr>
<td>Human capital</td>
<td>73</td>
</tr>
<tr>
<td>Physical infrastructure</td>
<td>42</td>
</tr>
<tr>
<td>Presence of large firms</td>
<td>40</td>
</tr>
<tr>
<td>Enterprise &amp; entrepreneurialism</td>
<td>38</td>
</tr>
<tr>
<td>Access to finance</td>
<td>35</td>
</tr>
<tr>
<td>Specialization</td>
<td>29</td>
</tr>
<tr>
<td>Access to markets</td>
<td>27</td>
</tr>
<tr>
<td>Access to business support services</td>
<td>25</td>
</tr>
<tr>
<td>Competition</td>
<td>21</td>
</tr>
<tr>
<td>Access to information</td>
<td>20</td>
</tr>
<tr>
<td>Communications</td>
<td>15</td>
</tr>
<tr>
<td>Leaderhip</td>
<td>13</td>
</tr>
<tr>
<td>Virtual aspects/ICT</td>
<td>11</td>
</tr>
<tr>
<td>External economic impact</td>
<td>8</td>
</tr>
</tbody>
</table>

**Table 17 Critical success factors in cluster development (Peck & Lloyd 2008, 404).**

Also, raising capital has become more difficult in the aftermath of the financial crisis. This leads to firms seeking capital on a broader basis, tapping into government funding programs and thus, looking for regions that offer grants and funding schemes. A paradox that emerged in recent years is that, while small biotech companies are often brimming with innovative new technologies and product candidates they are short on capital while big pharma companies have cash, however are hungry for new product ideas and scientific breakthroughs (Ernst & Young 2011). This implies that each cluster needs to have both, smaller companies with new ideas and big firms with the capital to fund them. Also, the connection between the two groups becomes all the more important. From a company perspective, the coordinated action affects both ends of the biotech business, the funding and innovation, as collaboration with government and research helps bring products to the market stage (Ernst & Young 2011). ‘Companies will need to work with policy makers and other stakeholders to develop solutions to boost investor returns to levels more commensurate with the risk they are currently taking’ (Ernst & Young 2011, 21).

It may be surprising that the leadership element is at the very bottom of this list in Table 17. However, the case studies revealed that stakeholders do not like the term ‘leadership’. Which means that when asked about a leadership role of any institution, they would deny that such a function exists within the network or that it would be an important contributor to the cluster. Digging deeper into the cluster set-up however would often reveal that there was a cluster manager in place that leads many initiatives related to networking. Hence, asking about leadership as done for this table is the wrong question altogether at least when trying to learn about cluster facilitation.

Overall, the life science industry has become more complex and competitive. The role of life sciences in health and aging populations has new competitors moving in. the drugs and pharmaceuticals subsector especially appears to be facing considerable
competitive challenges posed by the rise of generics, the slow pace of regulatory approval for new drugs and biopharmaceuticals and the continued fast pace of mergers and acquisitions as firms in the subsector seek long-term profitability (Biotechnology Industry Organization 2013). Also, the accumulated knowledge in the area has exploded, there are ‘more areas of potential use, more competing technologies, more pathways for product development and growing complexity as regard to proof of concept’ (IRIS 2009, 63). Investors have become more demanding in terms of commercial insight and market perspective and reluctant to invest into early-stage biotech projects. This development calls for a focus on those things that can be altered in the cluster, which include networking support mechanisms.

### 6.1.2. Facilitator characteristics

Based on the variation of cluster facilitation in the cases, the following Table 18 summarizes the characteristics of the types of network management:

<table>
<thead>
<tr>
<th>Cluster facilitator characteristics</th>
<th>Stakeholder recognition</th>
<th>Government recognition</th>
<th>Positive impact on the network&lt;sup&gt;58&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government- and stakeholder-financed</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Part of government</td>
<td>Medium to low</td>
<td>High</td>
<td>Medium to Low</td>
</tr>
<tr>
<td>Independent</td>
<td>High</td>
<td>High to medium</td>
<td>High</td>
</tr>
</tbody>
</table>

**Table 18 Cluster facilitator characteristics.**

This table might seem counter-intuitive at first, due to the fact that the independent facilitator has more impact on the network and is more widely recognized compared to the manager part of government or at least the one partly publicly financed. This does have to do with choosing an example in a US context, where government involvement is not welcomed as much as it would be in other countries. Further, the

<sup>58</sup> see Table 16 for the presence / absence of capacity elements.
independent facilitator, as described in the Chicago case study, can only be successful if the institution is able to gain trust and legitimacy among cluster stakeholders and government officials. This is done through having specialized knowledge in the specific industry and connecting to and communicating with cluster participants. There is almost a recognition cycle happening: The more connected the cluster facilitator is to industry and academia, the more legitimate the manager is in the eyes of government officials. This also works the other way around. The more lobbying power and information on government funding the manager has, the more trust-worthy facilitation becomes in the eyes of network members. Ultimately, due to its independence, the cluster facilitator has a high positive impact on the overall network. However, if the cluster facilitator is unable to establish trust with any of these groups, the impact diminishes. This distinguishes the independent facilitator from the other two models. While the independent manager has barely any impact without the trust and legitimacy of government and stakeholders, facilitators as part of or financed by government gain automatic legitimacy and thus can at least partially impact the network even with lower levels of recognition.

This is what happened in the Singapore example, where the facilitator is part of government. Even though not everyone agrees on the legitimacy of A*STAR as a cluster facilitator, the government agency still is able to pool competencies and funding opportunities and thus impact the network. However, the closeness to government also harms the image of the facilitator, as it is not seen as independent but rather acting in favour of government plans. This also limits the reach of the manager in terms of industry connections. In Singapore, having a government-operated facilitator is not as visible, because, as many interview partners pointed out, government is run like a business and many in government think in business terms. This might not be transferrable to other countries, which then have to pay special attention to their stakeholders connections if deciding on a government-run management for clusters.

For the final category of facilitation, government- and stakeholders financed, the case analysis in Medicon Valley shows that network members are committed to making facilitation work, but they also expect more in terms of services. Because they are paying to take advantage of the cluster organization they also expect to see results. And because results are not easily countable, especially for stakeholders such as universities, some members do get frustrated. There is also a fine line of how much the
cluster facilitator can charge, due to the fact that the goal is to include as many stakeholders as possible, also targeting smaller companies and start-ups that do not have the funds to spend a lot of money on facilitation. This is where the government funding portion can come in and take over costs for smaller stakeholders. However, in the Øresund example, government is in the process of phasing out public funding, which puts pressure on MVA to prove its use for the region. This poses the question if being too caught up in finding the funds to pursue capacity-enhancing activities and ultimately diminishes the facilitator’s effectiveness. However, the process of having more government funding in the beginning and then phasing it out by bringing in stakeholders does make sense. The early-on public funding gives the cluster management a platform to connect with more stakeholders. Once the use of that facilitation and the trust is established, stakeholders might be more willing to pay for some of the services offered. Overall, this facilitation model has a high impact on the network because it engages stakeholders and government alike through funding commitments. In the Medicon Valley example, it started out with European funding, then national government funding, mostly from the Danish side, and ultimately incorporating stakeholders.

What unites all three models is the learning component. In each case, except Vancouver, facilitators were able to learn from successful networks and incorporate elements for facilitation. In the Øresund Region the ambassador program pro-actively supports the learning process with best practice models by sending MVA employees to life science networks in Boston, San Diego and even China. After being part of the actual day-to-day activities undertaken in these clusters, the ambassadors report back to MVA and share their experience. In Chicago, the facilitator, iBIO has access to stakeholders that have participated in other cluster set-ups and can now share that experience. Chicago also adopted successful models, such as the mentoring program from Boston. Singapore learns slightly differently, by having ties to international investors that are able to educate Singaporeans on other models and share experience in the market.

In sum, the underlying, general features all facilitator model inherit are: First, the learning component, which implies that the facilitator is able to adopt practices and experiences from other clusters through experienced personnel or pro-active engagement in other networks. Second, the level of trust and legitimacy are an integral
part of the success of a facilitator, because it implies that government officials (if not part of government) and stakeholders are willing to work with the cluster management institution or person. And finally, the link to government, at least in the life science sector, is relevant, because a lot of the research and the start-up companies are dependent on public funding schemes. Any link that is able to inform them about these programs and lobby for their needs is a welcome addition to the network.

6.2. Preliminary results on cluster facilitators around the world

There are governance challenges and network weaknesses all stakeholders face in a cluster set-up. For government, different levels have different sets of competencies and tools – for example, while national and federal levels provide funding, a place-based component is often crucial to deal with actors on the ground. There is also an increased need for inter-ministerial and inter-agency committees designing programs and national plans for complex fields such as biotechnology. However, even if a country is able to develop according plans and set up a managing ministry or agency for cluster development, there is no guarantee for success. Often, the opposite is true. Common examples of governance ‘failure’ related to clusters include (OECD 2007): First, the establishment and funding of research clusters without proper connection to industry. Second, programmes to promote science and industrial parks at the local level are often not explicitly linked with the cluster policies or programmes originating at the national level. And finally, an overall lack of coordination ‘leaves some of the regional system isolated from the significantly greater resources available with those national programmes’ (OECD 2007, 123).

On the other end, industry and research stakeholders also struggle to pursue their goals in a cluster formation. Especially in life sciences, it is a research-intensive and expensive process before a profitable product is on the market. ‘Entrepreneurial companies face stiff obstacles; many companies stumble on the long and winding road from drug development, through regulatory approval to the medical market place’ (Powell, Koput & Smith-Doerr 1996, 122-123). Thereby, firms grow by being connected to benefit-rich networks. Those networks by no means sell themselves. Schrank and
Whitford (2011) find that networks fail if stakeholders are unable to sustain ‘desirable’ activities or impede ‘undesirable’ activities (155). Undesirable activities mainly being the pursuit of egoistic goals by one group. Another element to the success of a network, according to Human & Provan (2000) is its legitimacy. This describes the credibility of a network to members as well as outside constituents, such as funders or customers. Apart from networking obstacles, stakeholders also depend on favourable framework conditions for the cluster created by government policies, such as tax breaks or immigration legislation.

In sum, for both government and stakeholders from research and industry, there is a ‘liability of unconnectedness’ (Baum & Oliver 1992). Governments risk spending money in the wrong places and stakeholders run into issues of insufficient knowledge-sharing and learning from others. One solution for both is active cluster facilitation. The cases show – backed by survey results – the cluster manager serves several roles. First, ‘at the bottom’, the network institution helps to raise the levels of collaborative and absorptive capacity for stakeholders through establishing strategic goals, communication channels, identifying funding opportunities and connecting actors to outside stakeholders for knowledge transfer. At the same time the manager can articulate the needs of the cluster to government and arrange shared events. For government, the management tool is an entry-point to target the ongoing and often fast-paced developments. This includes challenges at cluster level that can only be tackled by national policies, such as immigration, housing or tax policy. Thus, government gets an idea of what is needed and at the same time can use the management tool to translate national programmes into more place-based projects and funding opportunities that directly apply to the region and the industry.

The common characteristics of cluster facilitators are that they are experts in the field they are working in and well connected to all three stakeholder groups of researchers, companies and government. The cluster management is also linked to government through funding and/or common committees and lobbying activities. Most importantly, facilitation creates the elements of collaborative and absorptive capacity. There is no one-size-fits-all approach to this kind of management as the structural and regulatory settings within each country or region affect the set-up. Further, government and manager have to be cautious about creating facilitation solely from the top or adding
an additional layer to an already complex multi-level governance set-up. Hence, the facilitation process does not always look the same, but should have the common characteristics outlined above. Also, everyone within the cluster can facilitate networking, but not everyone can be a facilitator who is strategically connected to key stakeholders with a plan how to bring the cluster forward.

A challenge that remains is the evaluation of such initiatives fostering innovation. The elements of networking and network management should be major factors when assessing innovative activities and their output. However, defining the individual elements of networking and network management to contribute to the evaluation discussion has proven to be difficult. The collaborative and absorptive capacity concepts help to tackle the complexity of networking functions by breaking them down into identifiable and – for some – measurable components of innovative activity. The analysis shows that under collaborative capacity framework, facilitators enhance face-to-face communication among stakeholders – including government, as well as overall networking. It also highlights the importance of common goals based on a policy or informal document and the formulation of a mission for the cluster. In terms of absorptive capacity, links to other clusters for knowledge-transfer are crucial and having a network manager to identify the (knowledge) gaps within the cluster. Beyond this, the analysis also pointed towards the fact that generally those with a facilitator did have more small-scale evaluations, which would imply that when evaluating clusters, those networks have more data to work with.

Overall, even with the help of the collaborative and absorptive capacity frameworks, evaluating innovative performance in clusters will remain a mixture of self-reporting and more objective assessments based on external data, because neither can capture the entire picture of performance. For such evaluations to be comparable there needs to be a coherent measurement system in place that ideally would send out surveys and track numbers at the same time and at the same policy level. This is not the case right now, however Europe is moving towards a more standardized system with the ‘Cluster Mapping Project’ and other efforts to stay ahead of the innovation measurement discussion. Another important aspect of evaluation in relationship to cluster facilitators is that the results are important input for the skill-set networks managers should possess.
As evaluation identifies possible gaps in the networking and innovation structure, these results should feed back into the facilitation process.

Overall, the relationship that is visible throughout the case studies is that the cluster facilitator is a link between government and stakeholders by encouraging elements that are part of the collaborative and absorptive capacity framework with the goal of enhancing performance. Building on the earlier figure (Figure 4) of the relationship between facilitation and performance, an advanced version would be the following (Figure 13):

**Figure 13 Facilitation Process.**

The figure describes the central position of the cluster facilitator in the relationship between stakeholders and government and the task of creating collaborative and absorptive capacity by managing the network and ultimately enhancing performance. The evaluation of that performance ideally would feed back into the policy initiatives as well as into the work of the facilitator. Due to the rather short time periods for the acknowledged existence of facilitators, the feedback loop is rather weak in all cases. However, for future research, the questions of how to evaluate cluster performance and the way it feeds back into science and technology policy as well as facilitation will be crucial.
In comparison to Figure 4, the above illustration further highlights the effects of not only the governance system, but also the national and regional innovation system and framework conditions. In other words, the contextual factors that might further limit or enhance the facilitation process. Framework conditions include current market developments in the sector the cluster is advancing in and possible first- or second mover advantages compared to other clusters. For example, as pointed out earlier, the biotechnology market currently features a ‘winner-takes-all’ model, which makes it difficult for emerging clusters to attract venture capital. Another question is how large economic downturns affect the ability of countries and multinational companies to invest into innovation. Investors might be willing to provide funding, ‘but it is being doled out in smaller increments and it comes with more strings attached and more risk ‘sharing’ (which typically means that more of the risk ends up being borne by smaller biotech companies)’ (Ernst & Young 2011, 2).

The facilitation process is further embedded in the innovation system of a certain country or region. The system includes economic, social, political, organizational and institutional factors that affect the cluster’s development. This relates back to the importance of location in terms of a region’s unique institutional endowment, which can act to support and reinforce local advantage for example (Asheim & Gertler 2005). The national and regional innovation system can be thought of as the institutional infrastructure, which coordinates the production function of the cluster. Asheim and Gertler (2005) even speak of a ‘regional culture’ that influences the practices of firms in a certain area, which in turn is the product of commonly experienced institutional forces.

The multi-level governance perspective draws attention to the interrelation between government levels and helps to identify some of the complexity of science and technology policy by highlighting the various levels and departments involved in framing innovation. It further shows which policies, regulations and funding schemes are already in place that the facilitation process has to learn about, incorporate or even strive to change to enhance performance. For example, general immigration laws as well as more detailed intellectual property regulations impact the cluster and thus the facilitation process. Overall, the facilitator has to – in collaboration with government – overcome market and system failures and also institutional weaknesses in order to enhance performance.
7. **Cluster policy at the crossroads**

7.1. **Introduction**

The chapters in the study shed light on the mechanism of cluster facilitation, which links government to stakeholders, supports public policy choices and creates networking opportunities. The analysis shows that stakeholders are affected by large- and small-scale policies alike and that government is dependent on communication with those affected to tailor the according policy tools. Cluster management can provide such a stakeholder perspective, due to its connection to network members.

Chapter 4 mapped out the ‘big picture’ elements of facilitation and its connection to government and stakeholders based on survey data. First, it showed that facilitation exists in different parts of the world and in a variety of sectors. Survey respondents came from Africa, Asia, Europe as well as North America and spanned sectors, such as life sciences, ICT, energy, environment or nanotechnology. The upshot of facilitation highlighted the fact that managers not only foster face-to-face networking among stakeholders, but also connect them with government officials. Further, all participants run into evaluation challenges due to the diverse data gathering techniques and the complexity of the process. As innovation moves from material inputs to immaterial and organizational aspects, ‘the targets of the policies become less measureable, the effects of the support provided by policy action acquire a long-term nature and the measurability of these effects decreases’ (Nauwelaers 2001, 96-97). The facilitator can, however, help with some aspects of evaluation, as a comparison of clusters with and without management showed that while clusters without facilitation mainly rely on project-based evaluation once a year or every two to three years, facilitated clusters portray a wider variety of project-based, cluster-wide and industry evaluation, which is done predominantly once a year. Project-based evaluation usually yields minimal results about the overall cluster, because it portrays one project. Results also are not comparable, as projects differ in lengths, size, funding and goals. In contrast, cluster-
wide and industry evaluations give a more complete picture of what is happening in the network. They might differ between networks, regions and countries, however, they provide a variety of hard and anecdotal data available that can help to make policy choices and give stakeholders and policy-makers a better idea of where the cluster stands. The role that the cluster organization plays in enabling more comparable evaluation is that they animate stakeholders to collect and combine that data and make it available for possible evaluators or use it to understand current and future dynamics for own use. Such data is also a tool in negotiations with the government when talking about funding schemes for the coming years or attracting companies to the cluster by emphasizing favourable data for entrepreneurial activity. Overall, cluster studies will have to rely on self-reporting and case-study analysis to yield performance results, as is currently done by the European Commission with so-called ‘innovation surveys’. The data limitations – both through external sources and the survey – demanded a more in-depth look at facilitation in clusters, which was done based on the interviews in four cases.

The analysis of the cases in Asia, Europe and North America in Chapter 5 documented the three variations of the facilitator model. The Medicon Valley cluster is an example for the government- and stakeholder-financed version, in which both groups support the management structure financially and are in close relationship with the facilitator. Singapore and Chicago have slightly different versions, as the cluster facilitator is part of government in Singapore and independent, meaning solely stakeholders-financed, in Illinois. Thereby the boundaries between the facilitation variations are fluid. The Medicon Valley Alliance is moving towards being solely stakeholder-funded and iBIO, in Chicago, is building a closer relationship with government. In contrast to those cases with facilitation, Vancouver highlights the frustration and untapped potential that occurs without proper communication between government and stakeholders as well as a strategic vision for the region and its industry. The cases also highlight the role of government in the cluster’s development through tailored funding initiatives and adjusting larger framework conditions informed by stakeholders.

From a comparative perspective, in Chapter 6, the study found that the variations in the facilitator model correspond to the according political systems and policy traditions
in each part of the world. With a stronger government position, predominantly in Asian countries, the facilitator is part of government, because it requires trust from official side while being backed by government in the eyes of stakeholders. In Europe, the European Commission as well as national governments play a role in clusters, due to Europe-wide regulations and funding competitions. This is why the facilitator is mostly government- and stakeholder-financed. Lastly, stakeholders in North America are rather reluctant to see government involved, which is why the facilitator is independent, but still has close ties to officials. Features all cases share include (1) a learning component, which means that the facilitator adopts practices and experiences from external sources through experienced personnel or pro-active knowledge transfer from other networks; (2) the level of trust and legitimacy are an integral part of the success of a facilitator, as government officials and stakeholders have to be willing to work with the cluster management institution or person; (3) the link to government is, at least in the life science sector, an essential part, because basic research and start-up companies are dependent on public funding schemes. The analysis further highlighted that, ideally, the facilitator is able to create a 'recognition cycle'. Because the management's legitimacy and trust are such integral parts of facilitation, it is important to be recognized in that position by both groups – government and stakeholders. The more connected the cluster facilitator is to industry and academia, the more legitimate the manager is in the eyes of government officials. This also works the other way around. The more lobbying power and information on government funding the manager has, the more trust-worthy facilitation becomes in the eyes of network members.

Going back to the hypotheses introduced in section 1.1., the analysis supports the fact that at least in the life science cluster set-up, the elements of trust, legitimacy, management and capacity-building are connected (H1). Tracking the development of facilitation in each case highlights the fact that building trust and legitimacy through expertise, experience and a connection to government are an integral part of the implementation and growth of cluster management. The interviews in each case further reveal that facilitation activities directly contribute to the capacity-building characteristics of stakeholders (H2). Most projects undertaken by cluster management did fit into the categories established by the collaborative and absorptive capacity frameworks. This
was further backed by the survey, in which respondents connected all capacity-building elements to facilitation work.

For the two remaining hypotheses, three and four, stating that there is a positive relationship between the levels of collaborative and absorptive capacity and ultimately between the presence of a cluster facilitator and the performance of the cluster, the evidence remains inconclusive, due to the fact that the survey did not deliver enough responses to give the basis for such a conclusion. Also, as described earlier, the data gathering process in various countries is very different, which makes the collection of coherent data on clusters almost impossible. The performance comparison done based on the four cases in connection with the existence of collaborative and absorptive elements and the extension of that with the linkage between the length of facilitation and competitiveness showed at least a trend that maps such a relationship. Future research on the subject will have to determine whether this holds for larger sets of cases and beyond the field of biotechnology.

Overall, due to the growing complexity of innovation and the pre-existing policies and instruments, government is working towards new ways to embrace clusters. And the study suggests that facilitation should be an integral part of (re)defining cluster policy.

7.2. At the crossroads

Cluster policy is at the crossroads practically and conceptually. Scholars have been successful in persuading policy-makers of the importance of clustering, but the role of government remains unclear. There has been a shift in the status of innovation from a means to achieve other economic objectives to becoming a policy goal itself (Perren & Sapsed 2013). However, due to scarce empirical evidence targeting the effectiveness of certain policy tools, a majority of governments around the world still rely on imitating successful examples, such as Silicon Valley, which often results in failure due to the tension between regional capabilities and policy initiatives. This final chapter revisits the challenging elements of cluster policy and shows how facilitation and capacity-building fit in.
7.2.1. **Current challenges**

Policy makers still work with an oversimplified view of the innovation process. This has many reasons, one of them being that there are few links to industry and following from this, a limited understanding of the local network. This implies, while government is well aware of the importance of innovation, it often treats the process as linear. A linear understanding of innovation addresses ‘inputs in the process rather than the functioning of the system, and providing support to firms in isolation rather than to networks of actors’ (Nauwelaers 2001, 102-103). Further, governments have difficulties finding a balance between taking a laissez-faire and a systemic approach to clusters. This means that decision-makers either only step in if there is obvious market failure, based on the neoclassical understanding of industrial policy or include all major policy fields in the attempt to redesign the linkages between parts of the system. The latter attempt requires specific insights not only into institutional characteristics of the national system, but also into the types of technologies and sectors being addressed. Both approaches have their advantages and disadvantages, however, the second perspective, more so than the first one, needs the input from stakeholders active in the according sector. Overall, researchers and practitioners agree that a balance between the two is necessary to support innovative capacity (Edquist et al. 2000; Ibata-Arens 2003; Pack & Saggi 2006). Thus, stakeholders and government are still in the process of agreeing on the right ‘policy mix’ of ‘old’ and ‘new’ instruments for clusters with the help of facilitation.

One example for better policy based on facilitation is the resolution of the ‘funding gap’. The simplified view of innovation often leads to a lack of financial support between basic research and commercialization. In recent years, ‘gap-funding’, informed by network managers, has become more popular. It targets exactly those entrepreneurs that work outside of university, but are often too small to support themselves or being recognized by venture capitalists or angel investors. The manager also ensures that government keeps pace with the developments in new technology fields and possible sub-sectors that are emerging. In Chicago, for example, the science park in the North of the city was able to create an interface between nano- and biotechnology, which will have a strong impetus for the medical device industry. Generally, the facilitator keeps government in touch with reality. Policy-makers are often unaware or even downplay the
variety of actor categories within one cluster. Hence, they zoom in on one group without including others, like individual researchers, small-and medium-sized companies or universities (Flanagan et al. 2011). Facilitators represent all these groups and can pinpoint urgent needs of some and long-term plans for others.

Table 19 gives a more complete list of the challenges governments face when addressing clusters. This summary of policy rationales, action and tools for clusters within the national and regional innovation system captures the bottlenecks of networking, however the tools listed are not easily applied. In fact, designing a proactive system to foster innovation has come to a point where it is ‘beyond the competence of any government to help’ (Pack & Saggi 2006, 44). More frequently in the last couple of years; researchers demand institutions that pose a channel or bridge for companies and other institutions to politics and government stakeholders (Martin 2012). As the case studies have outlined in detail, facilitator activities – often in collaboration with government – include most of these tools. Cluster facilitators are service-oriented and knowledge-based in the sense that they carry out and implement government-funded initiatives based on the information they have on what stakeholders need and want within the network. This includes networking programs, training, setting up platforms and technology centres as well as targeting the integration of start-up companies and researchers.

The cases further reveal that facilitators also help to make linkages outside of local agglomeration by building relationships with multinationals and investors. Conceptually these activities were categorized as supporting collaborative or absorptive capacity, however in practice, they blend into each other, as networking events for local stakeholders might include out-of-town companies and investors or outside-stakeholders inspire strategic visions for the cluster. By contributing to the network in this way, facilitators can prevent some of the common pitfalls in cluster policy. It also shows that policy has to actively identify system deficiencies before regional and local agglomerations can be successful as structures can weaken innovation due to creating ‘lock in’ or hindering network dynamics in form of ‘bottlenecks’ (Rosenberg 1982).
<table>
<thead>
<tr>
<th>Policy rationales</th>
<th>Cluster-oriented policy action</th>
<th>Tools</th>
</tr>
</thead>
</table>
| Lack of cluster identity and awareness | • Identification and public marketing of clusters | • Mapping exercises  
• External promotion of regional clusters  
• External/internal promotion of cluster member's competencies |
| Government regulations hamper innovation or competitiveness | • Organize cluster specific fora to identify regulative bottlenecks and take actions to improve them | • Cluster platforms and focus groups  
• Tax reform  
• Regulation reform (environment, labour markets, financial markets) |
| Firms do not take up opportunities to collaboration with other firms | • Encourage and facilitate inter-firm networking  
• Purchase innovative products through collaborative tender procedures | • Networking programs  
• Brokerage Training  
• Public procurement for consortia |
| Firms, particularly SMEs, cannot access strategic knowledge | • Support cluster-based retrieval and spread of information  
• Organize dialogue on strategic cluster issues | • Set up cluster specific information and technology centres  
• Platforms to explore market opportunities  
• Foresight exercises |
| Firms do not utilize the expertise of knowledge suppliers | • Collaborative R&D actions and cluster specific R&D facilities | • Set up cluster specific technology and research centers/initiatives  
• Subsidize collaborative R&D and technology transfer |
| Lack of crucial elements in a cluster | • Attract or promote growth of firms in cluster  
• Attract major R&D facilities | • Targeted inward investment  
• Support start-up firms in particular cluster |

*Table 19 Cluster policy rationales, initiatives and tools (Boekholt & Thuriaux 1999).*
7.2.2. Policy tools

The general shift of innovation policy to fuse science and technology policy with industrial policy by combining, for example, infrastructure, technical education, and intellectual property with investment grants, tariffs or trade policy, led to a ‘widening’ and ‘deepening’ of policy instruments (Rothwell 1982; Borras 2009; Perren & Sapsed 2013). In other words, instruments now include new and more sophisticated initiatives and expand the realm of action for innovation policy (Borras 2009; Flanagan et al. 2011). According to Flanagan et al. (2011) this hints towards the fact that today’s economies depend on more than traditionally conceived science and technology policy and will rely on a mix of ‘indirect’ as well as traditional ‘direct’ measures, ‘demandside’ as well as ‘supply-side instruments’ (Flanagan et al. 2011, 703).

The emergence of the knowledge economy and the according adjustments made by policy, have invaded traditional policy fields and instruments (Nauwelaers & Wintjes 2008). This has lead to conflicts between tools and ultimately to the layering of instruments (Barnett et al. 2009; Buckman & Diesendorf 2010; Howlett 2011), which heightens the need for expert input. The facilitator can offer such support, as the decision for applicable instruments is the most complex part, while the set of possible choices is limited in nature (Hood 2007; Howlett 2011).

Understanding the basic types of instruments available to policy-makers and establishing the criteria that policy experts use for assessing the advantages and disadvantages of their use is essential knowledge required to understand how designs emerge and thus to aid in the creation of new ones as well as the assessment and improvement of existing ones. (Howlett 2011, 57)

The following matrix summarizes the form and focus of innovation support in form of the target and the level of activity (Figure 14). The size of the letters indicates the emphasis placed upon this type of innovation support. The hope is that when a cluster facilitator is in place, more instruments will focus on the D-quadrant, which supports the procedural components of innovation while also targeting the regional set-up. This, of course, requires a high degree of understanding of stakeholder behaviour in clusters as well as self-reflexive capacity and openness to evaluation (Nauwelaers 2001).
In addition to nationally-rooted challenges, these activities happen within a global innovation structure, which affects the local agglomeration in various ways.

7.2.3. **Local agglomeration in a global economy**

Much has been written about the leveling effects of technology due to ICT, which to scholars like Friedman (2005) erodes the economic importance of geographic place. The argument is that local occurrences are shaped by events occurring miles away and vice versa due to increased interdependency and interrelatedness among actors (Giddens 1990). However, in innovation, Archibugi and Iammarino (2002) show that there is always a local dimension to the day-to-day activities of stakeholders. They identify three forms of ‘global innovation’: (1) Centre-for-global; (2) Local-for-local and (3) local-for-global. The first one describes a multinational company having a headquarter in one location and then venturing out to sell their product, while local-for-local means that each ‘subsidiary of the firm develops its own technological know-how to serve local needs’ (Archibugi and Iammarino 2002, 104). And lastly, multinationals distribute R&D and technological expertise in a variety of host locations. This allows the company to
develop each part of the innovative process in the most suitable environment. Further, Florida (2005) argues that globalization has increased the returns to innovation by diffusing them quickly and widely, strengthening the lure that innovation centres hold—which in return reinforces their productivity. He points out that the local centres become increasingly important as the world becomes more global (Florida 2005; Wolfe 2009).

Thereby, the learning going on at local levels and the globalizing dynamics of the economy strongly reinforce each other as local findings make their way into global markets and multinationals become knowledge carriers for local companies (Archibugi & Iammarino 1999; Lundvall & Archibugi 2001). The key is to combine both to profit from access to the global economy while developing innovation capacities locally. In other words, focusing on spatial agglomeration in an increasingly globalized world is deemed a successful strategy for an economy. The capacity to innovate remains in the face-to-face interaction between stakeholders happening locally. Thus, those arguing for the complete globalization make no distinction between information and tacit knowledge (Kahin 2009). Information can be codified and transferred to places around the globe. Tacit knowledge however, is learned and imitated in person and cannot be replaced by any electronic communication. ‘Innovative capabilities are frequently sustained through regional communities that share a common knowledge base and interact through common institutions’ (PROGRIS 2006). Facilitators pose such a common institution by supporting face-to-face interaction.

In sum, ‘while globalization may call into question the applicability of early 20th century industrial policy, by no means does it obliterate location, geographic advantage, or uneven gains resulting from such advantage’ (Hira et al. 2013, forthcoming). Instead, it has pushed governments and industry to identify the competitive advantage of places at an international level. This advantage is not only rooted in output performance anymore, but also in the effectiveness of networking, knowledge exchange and links between local and global players. In fact, we see a convergence between the competitiveness of the company as a result of globalization and the competitiveness of the place. This supports the use of the collaborative and absorptive capacity framework, as they combine the two dimensions and account for the competencies of the network to exchange information locally and with global stakeholders. The Singapore case showed that global companies and players can bring knowledge into the local cluster through
investment and cooperation. In tandem, governments and facilitators can foster such developments by attracting those companies to the region, mainly based on tax breaks, state-of-the-art facilities or advertising geographic advantages.

Overall, facilitation often poses the key element in realizing successful cluster policy by connecting local agglomeration to globalization. However, facilitation is established over a period of time to gain the trust of stakeholders and make connections to government. Cluster management has to adjust to location-specific and global developments. Further, flaws rooted in the system cannot be overcome by cluster facilitation alone. If, for example the patent filing system does not live up to international standards or funding for basic research is restricted, even managers reach the limits of boosting cluster performance.

### 7.2.4. Facilitation

A key to facilitation success is the trust from stakeholders and government in network management. If, from a stakeholder perspective, cluster facilitation seems to be solely guided by politics and that trust is broken, relationships established through facilitation become tainted. Also, following a similar logic, if the cluster manager seems to have its own vested interest in cluster developments and therefore a skewed perspective on the ongoing developments, stakeholders and government are quick in turning away. This means the facilitator possibly loses the core node position in the network and no longer holds the key to supporting collaborative relationships and communicating strategic visions to network members. Sometimes, especially if outside linkages are missing, cluster managers can also be ‘overly involved’ in the sense that they lose the perspective to see the bigger picture and steer the cluster accordingly.

In addition, the smooth implementation and development of cluster facilitation is more efficient when existing opportunities are exploited rather than opening up new avenues (Lundvall 2001). This implies that policy-makers should tackle regions that already have a certain level of agglomeration in one industry or field and unite those competencies with university research and companies. This can then become the basis on which facilitation can be built on. Again, taking into account the regional and local characteristics instead of emulating successful models is crucial to enabling the cluster.
As outlined in the case studies, all of them had prior structural set-ups connected to a low-tech or medium-tech industry that could be used and developed for the facilitation of a high-tech cluster. Thus, when evaluating the potential of a region for being successful, policy-makers not only have to think about present and future competitiveness, but also about past set-ups that enable cluster development.

As Feldman and Florida (1994) highlight, the ‘capacity to innovate is very much the historical legacy of specialized concentrations of R&D, industrial activity, and support services that build up in particular places over time’ (226). They further describe the importance of cumulative investments in specific places over a longer period of time. These can include, for example, the development of a technological infrastructure with agglomerations of manufacturing firms in related industries and the concentration of industrial and university R&D, which then create the regional ‘stock’ of innovative capabilities. Feldman and Florida (1994) base their findings on the strong geographic concentration of production innovation in the US, which collides with the prior infrastructural set-up. A more radical version of this argument would suggest that ‘cluster development is path dependent or heavily influenced by chance historical events’ (Kenney & von Burg 1999; Feldman & Francis 2004, 132). The policy implications derived from these findings include the acknowledgement of pre-existing traditions of interaction and establishing an infrastructure and other goods that the market fails to provide. To match government support with the existing set-up, Feldman and Francis (2004) point out the need for communication between entrepreneurs and officials, as government often focuses its attention on ‘relocating firms, offering one-off special deals and other incentives, rather than understanding the needs of existing firms and providing solutions’ (Ibid, 134). Therefore, the facilitator becomes an important link not only to the stakeholders themselves, but also to the historical legacy of the region and the opportunities created by them. Beyond the acknowledgement of historical legacies, Bailey et al. (2010) also highlight the role of a network manager in adjusting trajectories towards knowledge-intensive activities. They find that deep knowledge of the region is needed in order to renew and reposition local production systems. Repositioning can take place based on three mechanisms: First, entering and securing high value-added market segments by moving away from mass production and price competition. Second, by using cross-fertilization and search for market opportunities beyond its usual final
customer. And finally, repositioning the region in the global value chain, which implies a shift in its core competencies (Bailey et al. 2010). The facilitator plays a role in all three of these adjustments and has the ability to inform and guide the process based on knowledge of the region, the stakeholders and the connection to government.

Overall, many of the advantages of clusters arise from face-to-face interaction. And while government might be guilty of ‘black boxing’ stakeholders in the network, the same is true for industry players and researchers towards government (Flanagan et al. 2011). Interaction between both groups can solve the problem. This can be as simple as regular meetings, facilitated by a manager, where representatives of each group get together. In all cases, interviewees emphasized that during such meetings they got the contact information of cluster members and were able to get in touch outside of organized meetings or clarify issues related to funding, latest industry developments or projects. One crucial element for this manager-supported activism to happen is the willingness of stakeholders and government to talk to each other. Here, sometimes pre-judgements about the involvement of government get in the way.

7.3. Study limitations

Most of the limitations derive from the methodology chosen for this study. While the case study approach and the survey display some important strengths that enriched the research, they also limit the findings. First, focusing on Chicago, the Øresund Region, Singapore and Vancouver takes away some of the generalizability of the results. Even though the study concludes upon three facilitation models that capture most cluster management approaches, they are derived from developed countries in the Western hemisphere and Asia. This neglects a large group of developing and emerging economies, which also have high-tech clusters and management models. This is an area for future research, as developing and emerging countries bring a new set of challenges when it comes to science and technology policy and funding. This does not mean that the three models will not be applicable in those countries, but this is a conclusion that currently cannot be drawn from the study.
A challenge for both the survey and the case study research was the terminology connected to facilitation. While research and industry stakeholders unitarily were reluctant to name anyone the ‘leader’ of a network or cluster, the terms for facilitation varied. This is also true for most of the literature on the subject. The descriptions used for facilitation include:

- cluster/ network facilitator
- cluster/ network manager
- cluster/network organization
- cluster initiative (spearheaded by a facilitator)
- industry organization

Further, the cases are taken from the biotechnology field, which is a specifically demanding in terms of networking. One could argue that this is why a cluster facilitator is needed more in this area. However, clustering is happening in other areas as well, including high-, medium- and low-tech. And the survey shows that the facilitation concept does go beyond the biotechnology field with stakeholders from energy, food production or oil and gas reporting the application of cluster management. However, the question remains if just one or all three models apply in these areas, especially in fields where government involvement is higher or lower than in the biotechnology example. It may be that for highly regulated fields, facilitation happens through a government department or is funded by government, while fields where government involvement is minimal, network management is predominantly independent.

Another aspect the study does not account for, but will be subject to further exploration, is the time lag between the beginning of facilitation and improved performance. The dissertation makes the connection between higher levels of performance and cluster management, but cannot make a conclusive assumption about how long facilitation has to be in place for it to positively impact the cluster. Figure 11 is a first attempt at grasping the length of facilitation in connection with output measures, but due to the low response rate of the survey, the study can only describe a trend rather than definite results.

Overall, the case study approach has the trade-off of offering insight into the phenomenon of cluster facilitation and capturing the complexity of it, but limits the
generalization of the results. Ultimately, the geographic scope and the inclusion of all three stakeholders groups supports the study in the development of the three facilitation models, but one has to be cautious about their application in developing and emerging economies and for medium- and low-tech industries.

7.4. Future research

Overall, the research is a snapshot and comparative status-quo assessment of cluster management inside innovative networks, including the perspective of industry stakeholders, researchers and government officials. This is valuable to understand how facilitation works and why it helps stakeholders connect and ultimately innovate. The analysis of the cluster facilitation model in the biotechnology field further generates a variety of future research projects, which include the advancement of the model conceptually, empirically and expanding it geographically.

First, for the conceptual expansion of cluster facilitation, there is more work to be done to establish and connect it to network management theories. Starting out with pooling the bits and pieces on cluster facilitation that have been written over the last couple of years and matching or adding them to more established theories of network management. Also, most theories lack the empirical backing, which makes it difficult to establish a list of characteristics and components of cluster facilitation that actually work. Using the collaborative and absorptive capacity framework to identify these components is a first step towards strengthening not only the cluster facilitation, but also the larger framework of network management theory. Ultimately, the topic of cluster facilitation suffers of a chicken and egg problem. While there has not been enough evidence gathered to back some of the concepts, the concepts are not well-developed enough to systematically look for evidence. Using the capacity framework breaks that cycle by identifying separate elements important for the manager to establish. Moving along the lines of the capacity framework and developing it further will help to systematically compare and strengthen the empirical evidence.

This means gathering more empirical evidence in other cases and other parts of the world is crucial. While the current study looks at emerging clusters in the high-tech
sector, there is room to explore the most successful and weaker examples of biotech and high-tech networks. Boston and Silicon Valley would pose cases for successful clusters. Beyond the well-known and noted universities in both networks, the question is ‘what worked’ and what is generalizable for other clusters in North America and beyond and which of these elements can be supported by the tandem of facilitation and government work. And since the online survey technique only seems to capture small fractions of the cluster population, interviews in the according cases would probably be more fruitful. The same applies to research in unsuccessful clusters. Stakeholders might be more reluctant to talk in those cases, however, important lessons on what went wrong may be learned here. Those include the often-named New Jersey example in which the attempt to create a Silicon Valley high-tech sector only led to a limited research consortium (Leslie & Kargon 1997; Feldman & Francis 2004). Australia, after much success, also seems to have experienced a slow-down in cluster development. Some interview partners in Singapore hinted that the actions of government affected the slow-down. Again, the question is, ‘what went wrong’ and could a cluster facilitator have prevented this.

Further, clusters do not only occur in developed countries. Developing countries also make use of the positive effects of spatial agglomeration. While some countries adopted the Asian model of science and technology parks, most struggle with larger policy approaches, which include protecting local companies from competition and restricting industrial areas. Both measures hinder cluster development, because companies are unable to cluster around universities and make use of the positive effects of competition, such as transformation pressure, motivation to be more efficient and developing absorptive capacities (Lundvall & Christensen 2003). These cases would not only be an interesting example of the examples of policies that hamper cluster development, but also what effects a cluster facilitator would have in terms of communicating the needs of companies and research facilities to the according decision-makers.

As mentioned, the Asian model heavily relies on technology and science parks to deliver innovation. This entails different dynamics than a cluster set-up and leads to variations in policies and networks. The question is if science parks have the potential to develop into a cluster through the help of a facilitator. Another aspect to innovation policy
in Asian countries is the fact that government is more involved in the enforcement than in, for example, Western countries. Thus, the question remains how this strategy fits into a national and regional innovation system and if this helps or hinders cluster development in the long-term.

This ties into the discussion of the relationship between facilitation and the evolution of clusters over time. Based on the assumption that some researchers make that clusters have a life cycle, facilitation might vary. Williams (2005) suggests a S-curve with four stages of latent, developing, established and transformational cluster development. Enright (2003) identifies a five-stage model with potential clusters, latent ones and working clusters. In a wider sense, the primary lesson from a historical discussion of innovation is the heterogeneity of the innovation process across time, across sectors and across countries. Historical evidence highlights the informal processes of knowledge accumulation, learning and dissemination (Bruland & Mowery 2005). Thus, while the larger innovation system changes over time with fluctuations in state involvement, funding structures and the direction of industry, the cluster also evolves through various stages. The question remaining is how the facilitator has to adjust to these changes over time. In the early stages of the cluster, for example, stakeholders have different expectations and needs than in the mature phase of network development. In the beginning, the facilitator might focus on goal creation, strategy development and trust-building, while in later stages continued resource support and outside collaboration might become more important. This implies that the elements of collaborative and absorptive capacity carry different weight as the cluster evolves and the facilitator – in close linkage with industry, research and government – has to shift focus depending on current cluster needs. Future research is needed to identify how the preferences are distributed in each stage and at which point a shift happens. This could be measured by comparing clusters in the same industry, but in different ‘life-stages’ and listing the most important elements of facilitation work.

The study further reveals that there is a complicated relationship between government and industry stakeholders. Part of understanding and adapting to local conditions is the collaborative effort between government and SMEs and MNCs. So far, the cases show that industry in most countries is reluctant to have government agencies involved in the development of high-tech fields, however, in the course of sector
evolvement, framework conditions shaped by government are a crucial element for long-term success. The question remains, how these collaborative efforts can be structured and managed to gain a common understanding of furthering certain industries with the support of government and what role cluster facilitators can play in this specific relationship. This is based on country-specific frameworks for the involvement of government in certain fields, however this aspect of innovation will become more important throughout the coming years when health and environmental challenges push collaboration between both groups. Because the healthcare sector and climate change are often heavily regulated, industry needs to communicate extensively with government to be innovative. Network management is an important link between the two and needs further analysis connected to social issues.

More generally, the survey showed that cluster facilitators exist in other fields, which points towards expanding the analysis to other research areas where clustering is happening. This would not only include health-related and climate change fields, but also manufacturing, ICT or food production. This would show if the management model is applicable in similar ways in other areas, including the elements of the collaborative and absorptive capacity framework or if it needs to be adjusted once applied outside of high-tech sectors.

Finally, another step is to understand if cluster management changes and affects networking and thus performance over time. This is strongly related to the development of more generalizable and comparable performance measures. Specifically, finding factors that make the difference in performance, and output data that tracks said difference. For that purpose, a deeper understanding has to be developed about how to measure the conceptual framework and which data is comparable across countries and continents. Two problems arise from the current data gathering process: First, there is no common list of proxies for innovative activity. Instead different countries use different measures to express their level of innovation. The OECD and WHO on the other hand, make a selection of countries they evaluate and mostly remain at the national or regional level, but do not provide data for clusters. Second, the data gathering process itself in each country differs. This implies that if two countries measure the number of patents, they do not necessarily measure the same thing, depending which patent database they refer to and at which level (national, regional, local) they count. This makes it almost
impossible to compare data across countries. In sum, the development of new proxies for the measurement of cluster performance and the search for comparative measures across countries is essential to further develop the cluster facilitation model. Also, facilitation aspects that have been developed by this study should be included in the set of new proxies.

7.5. Final thoughts

Clustering and cluster policy are not economic quick fixes, even if some policy documents promise major improvements through support and creation of such high-tech networks. Some might even suspect that the ‘buzz’ around clusters is used by policy-makers to create a halo effect for other projects that have been on the back bench (Nauwelaers 2001; Perren & Sapsed 2013). Further, cluster policy has multiple facets: from framework support to targeted initiatives or even ‘picking winners’. What is often forgotten is to distinguish between the support for a product versus for a process and to account for the difference between information and knowledge. The oversimplification of innovative processes leads to gaps in funding and often does not create the capacities needed to network and exchange tacit knowledge. In contrast to information, knowledge is needed to push new process, product, organization and marketing innovation. These elements, the connectivity based on the process and the exchange of knowledge, keep clusters locally-bound, but not without the influence from global developments and multinational companies. In fact, the ‘global pipelines’ need to be actively incorporated into the ‘local buzz’ of clustering (Wolfe & Creutzberg 2003). While these tasks are complex and require a level of oversight, governments and stakeholders both only have limited capabilities to address these issues. The cluster facilitator is the solution suggested by this study, because this institution or person enhances the collaborative and absorptive capacities of the cluster while posing a link between government and stakeholders. Instead of proposing a ‘best practice’ model, the cases have shown that this mechanism can account for local characteristics and different forms of the political system.

The implementation of a facilitation mechanism in the realm of science and technology policy is also a public management innovation in itself. Such structural
changes challenge government to rethink current working ethics and more importantly, enter a state where they are conducive to learning. The implementation of cluster facilitation is no easy task as it changes the dynamics of long-standing structural and institutional frameworks in mostly nested, multi-level political systems. Also, it enters an arrangement in which instruments and goals have been added to existing ones – the process of layering – which often leads to incoherence amongst the policy ends and means (Howlett 2011). Thus, the network management tool might not always be successful in redesigning or replacing existing elements and has to find a compromise for an arrangement with current policy tools. This might reduce its capacity-enhancing abilities. Overall, the success of cluster facilitation is dependent on a variety of factors, including structural and organizational pre-conditions, current policy frameworks and the coherence of policy instruments. It challenges existing set-ups for science and technology policy and over time helps to make innovation policy more coherent and knowledgeable about on-the-ground needs and helps navigate the complexity of innovative activity within networks.
8. References


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Appendices
Appendix A. Survey cluster performance sorted according to length of facilitation


- UE = Unemployment rate
- P = Number of patents
- HTE = High-tech Employment rate
- FB = Firm births

<table>
<thead>
<tr>
<th>42 clusters</th>
<th>Sector$^{59}$</th>
<th>Length of facilitation$^{60}$</th>
<th>Overall performance</th>
<th>Performance ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aalborg, Nordjylland, Denmark</td>
<td>Life Sciences</td>
<td>more than 5 years</td>
<td>UE: 7.9, P: 1.2, HTE: 0.42, FB: 3,008</td>
<td>nationally competitive</td>
</tr>
<tr>
<td>Boston, Massachusetts, USA</td>
<td>Life Sciences</td>
<td></td>
<td>UE: 7.0, P: 535, HTE: 0.38, FB: 18,581</td>
<td>high-performance</td>
</tr>
<tr>
<td>Hillerod, Hovestaden, Denmark</td>
<td>Life sciences</td>
<td></td>
<td>UE: 8.2, P: 1.2, HTE: 0.5, FB: 12,972</td>
<td>nationally competitive</td>
</tr>
<tr>
<td>Melbourne, Australia</td>
<td>ST</td>
<td></td>
<td>UE: 5.4, P: 444, HTE: 0.21, OECD ranking: #17</td>
<td>high-performance</td>
</tr>
<tr>
<td>Montreal, Canada</td>
<td>ICT</td>
<td></td>
<td>UE: 10.2, P: 113, HTE: 0.16, OECD ranking: #17</td>
<td>high-performance</td>
</tr>
<tr>
<td>Singapore</td>
<td>Life Sciences</td>
<td></td>
<td>UE: 1.9, P: 82, FB: 3,226</td>
<td>nationally competitive</td>
</tr>
<tr>
<td>Stenungsund, Vaestra</td>
<td>Manufacturing</td>
<td></td>
<td>UE: 7.7, P: (general: 448), HTE:</td>
<td>nationally competitive</td>
</tr>
</tbody>
</table>

$^{59}$ based on self-assessment by cluster members and cluster facilitators.

$^{60}$ based on self-assessment by cluster members/cluster organizations.
<table>
<thead>
<tr>
<th>Location</th>
<th>Sector</th>
<th>Years</th>
<th>UE</th>
<th>P</th>
<th>HTE</th>
<th>FB</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goetaland, Sweden</td>
<td>Energy</td>
<td></td>
<td>0.7, FB: 11,860</td>
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<td></td>
<td></td>
<td>high-performance</td>
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<tr>
<td>Tampere, Pirkanmaa, Finland</td>
<td>Energy</td>
<td></td>
<td>UE: 7.5, P:190, HTE: 0.69, FB: 917</td>
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<td></td>
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<td>high-performance</td>
</tr>
<tr>
<td>Uppsala, Sweden</td>
<td>Life Sciences</td>
<td></td>
<td>UE: 8.6, P:25.7, HTE: 0.7, FB: 2,664, OECD rank: #3</td>
<td></td>
<td></td>
<td></td>
<td>high-performance</td>
</tr>
<tr>
<td>Vaasa, Pohjanmaa, Finland</td>
<td>Energy</td>
<td></td>
<td>UE: 8.2, P:27, HTE: 0.69, FB: 133</td>
<td></td>
<td></td>
<td></td>
<td>nationally competitive</td>
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<tr>
<td>Zurich, Switzerland</td>
<td>Life Sciences</td>
<td></td>
<td>UE: 3.6, P:464, HTE: 0.78, FB: 6, 674</td>
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<td></td>
<td></td>
<td>nationally competitive</td>
</tr>
<tr>
<td>Frederikssund, Hovestaden, Denmark</td>
<td>Cleantech</td>
<td>3-5 years</td>
<td>UE: 8.2, P:2.4, HTE: 0.7, FB: 12,972</td>
<td></td>
<td></td>
<td></td>
<td>nationally competitive</td>
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<tr>
<td>Oakland, California, USA</td>
<td>Food Production</td>
<td></td>
<td>UE: 10.8, P:x, HTE: 0.32, FB:103,572</td>
<td></td>
<td></td>
<td></td>
<td>high-performance</td>
</tr>
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<td>Amsterdam, North Holland, NL</td>
<td>Life Sciences</td>
<td></td>
<td>UE: 5.0, P:39, HTE: 0.4</td>
<td></td>
<td></td>
<td></td>
<td>nationally competitive</td>
</tr>
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<td>Austin, Texas, USA</td>
<td>Life Sciences</td>
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<td>UE:4.5, P:24, HTE: 0.18, FB:55,214</td>
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<td>high-performance</td>
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<td>Chicago, Illinois, USA</td>
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<td></td>
<td>UE: 10.3, P:81, HTE: 0.29, FB:31,493</td>
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<td></td>
<td></td>
<td>high-performance</td>
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<tr>
<td>Didcot, South Oxfordshire, South East, UK</td>
<td>Life Sciences</td>
<td></td>
<td>UE: 5.6, P:24.4, HTE: 0.88,FB:36,000, OECD rank: #16</td>
<td></td>
<td></td>
<td></td>
<td>high-performance</td>
</tr>
<tr>
<td>Dunedin, New Zealand</td>
<td>ICT</td>
<td>1-3 years</td>
<td>UE:6.9, P:2.5, HTE:0.19(all NZ),FB: 42,370 (all New Zealand)</td>
<td></td>
<td></td>
<td></td>
<td>low performance</td>
</tr>
<tr>
<td>Gdynia, Kujawsko-Pomorskie, Poland</td>
<td>Environment/Energy</td>
<td></td>
<td>UE: 9.5, P:1 HTE: 0.26, FB: 18,289</td>
<td></td>
<td></td>
<td></td>
<td>nationally competitive</td>
</tr>
<tr>
<td>Hanover, Niedersachsen, Germany</td>
<td>Energy</td>
<td></td>
<td>UE: 5.5, P:8.7, HTE: 0.7, FB: 33.886</td>
<td></td>
<td></td>
<td></td>
<td>low performance</td>
</tr>
<tr>
<td>Molde, Vestlandet, Norway</td>
<td>Oil &amp; Gas</td>
<td></td>
<td>UE: 2.9, P:27, HTE: 0.51, FB: 1,611</td>
<td></td>
<td></td>
<td></td>
<td>nationally competitive</td>
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<td>City</td>
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<tr>
<td>Vancouver</td>
<td>Environment/Energy</td>
<td>UE: 6.3, P:14, HTE: 0.29, FB: 4,504</td>
<td>nationally competitive</td>
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<tr>
<td>Zoetermeer, South Holland, NL</td>
<td>Life Sciences</td>
<td>UE: 6.3, P:52, HTE: 0.67</td>
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<td></td>
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<tr>
<td>Zurich, Switzerland</td>
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<td>UE: 3.6, P:27.6, HTE: 0.78, FB: 6,674</td>
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<td>UE: 7.9, P:0.5, HTE: 0.42, FB: 3,008</td>
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<tr>
<td>Great Yarmouth, East of England UK</td>
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<tr>
<td>Oslo, Norway</td>
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<tr>
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<td>UE: 7.4, P:21, HTE:0.19(all NZ),FB: 42,370 (all New Zealand)</td>
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<td>Life Sciences</td>
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<td>high-performance</td>
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<tr>
<td>Copenhagen, Denmark</td>
<td>ICT</td>
<td>UE: 8.2, P:31, HTE: 0.5, FB:4,457</td>
<td>nationally competitive</td>
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<tr>
<td>Edmonton, Canada</td>
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<tr>
<td>Gothenburg, Vaestra Goetaland, Sweden</td>
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<td>Johannesburg, Gauteng, South Africa</td>
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<tr>
<td>Madrid, Spain</td>
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<tr>
<td>Oxford, South East UK</td>
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<tr>
<td>Roskilde</td>
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<tr>
<td>Country</td>
<td>Sector</td>
<td>UE: P: HTE: FB:</td>
<td>Performance</td>
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<tr>
<td>Denmark</td>
<td>Manufacturing/ Energy</td>
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<td>competitive</td>
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<tr>
<td>San Juan, New Mexico, USA</td>
<td>Life Sciences</td>
<td>UE:5.8, HTE: 0.15, FB:5,971</td>
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<td>Saskatoon, Canada</td>
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<td>Tranent, East Lothian, Scotland</td>
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<td>Uppsala, Sweden</td>
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<td>low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vancouver, Canada</td>
<td>Life Sciences</td>
<td>UE: 6.3, P:25.7, HTE: 0.29, FB: 4,504</td>
<td>low</td>
<td></td>
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</table>
## Appendix B. Anonymized list of interview partners

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Position of Interview partner</th>
<th>Organization Type</th>
<th>Date of face-to-face meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vancouver</td>
<td>Director</td>
<td>Research organization, Corporate Development subdivision</td>
<td>Tuesday, March 27, 2012 – 4pm</td>
</tr>
<tr>
<td>Vancouver</td>
<td>Director</td>
<td>Research organization, program management subdivision</td>
<td>Thursday, March 29, 2012 – 1pm</td>
</tr>
<tr>
<td>Vancouver</td>
<td>Director</td>
<td>National, not-for-profit research organization coordinating collaborative industry-university research projects</td>
<td></td>
</tr>
<tr>
<td>Vancouver</td>
<td>Director</td>
<td>Research organization, Business development subdivision</td>
<td>Friday, March 30, 2012 – 1pm</td>
</tr>
<tr>
<td>Vancouver</td>
<td>President</td>
<td>Life science non-profit industry association</td>
<td>Tuesday, April 3, 2012 – 10am</td>
</tr>
<tr>
<td>Vancouver</td>
<td>Vice-President</td>
<td>Research organization, Operations subdivision</td>
<td>Wednesday, April 11, 2012 – 12pm</td>
</tr>
<tr>
<td>Medicon Valley (Copenhagen)</td>
<td>CEO</td>
<td>Cluster Organization</td>
<td>Tuesday, July 3, 2012 – 9am</td>
</tr>
<tr>
<td>Medicon Valley (Copenhagen)</td>
<td>Department Head</td>
<td>Danish University</td>
<td>Tuesday, July 3, 2012 – 11am</td>
</tr>
<tr>
<td>Medicon Valley (Copenhagen)</td>
<td>Senior Vice President</td>
<td>Danish University</td>
<td>Tuesday, July 3, 2012 – 3pm</td>
</tr>
<tr>
<td>Medicon Valley (Copenhagen)</td>
<td>Co-Founder &amp; Partner</td>
<td>Biotechnology Company</td>
<td>Wednesday, July 4, 2012 – 2pm</td>
</tr>
<tr>
<td>Medicon Valley (Copenhagen)</td>
<td>Senior Advisor</td>
<td>Regional government agency</td>
<td>Thursday, July 5, 2012 – 10am</td>
</tr>
<tr>
<td>Singapore</td>
<td>Director</td>
<td>Government agency, Subdivision for Research</td>
<td>Thursday, February 7, 2013 – 3pm</td>
</tr>
<tr>
<td>Singapore</td>
<td>Deputy Executive Director</td>
<td>Government agency, Subdivision for Biomedical Research</td>
<td>Friday, February 8, 2013 – 4pm</td>
</tr>
<tr>
<td>Singapore</td>
<td>CEO</td>
<td>Research Institute</td>
<td>Wednesday, February 13, 2013 – 11am</td>
</tr>
<tr>
<td>Singapore</td>
<td>Director</td>
<td>Research Institute</td>
<td>Wednesday, February 13, 2013 – 3pm</td>
</tr>
<tr>
<td>Singapore</td>
<td>Vice-President</td>
<td>Biotechnology company</td>
<td>Friday, February 15, 2013 – 10am</td>
</tr>
<tr>
<td>Location</td>
<td>Position</td>
<td>Organization</td>
<td>Date and Time</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>--------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Singapore</td>
<td>Director</td>
<td>Research Institute</td>
<td>Friday, February 15, 2013 – 2pm</td>
</tr>
<tr>
<td>Singapore</td>
<td>Scientist</td>
<td>Biotechnology company</td>
<td>Friday, February 15, 2013 – 3.45 pm</td>
</tr>
<tr>
<td>Singapore</td>
<td>Director</td>
<td>University research Institute</td>
<td>Tuesday, February 19, 2013 – 11am</td>
</tr>
<tr>
<td>Singapore</td>
<td>Chief Executive Officer</td>
<td>Technology Transfer Office</td>
<td>Tuesday, February 19, 2013 – 3pm</td>
</tr>
<tr>
<td>Singapore</td>
<td>Senior Vice President</td>
<td>Technology Transfer Office, Investment &amp; Spin-off division</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>Vice President</td>
<td>Technology Transfer Office, Biomedical Division</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>Head of Public Affairs &amp; Market Access</td>
<td>Biotechnology company</td>
<td>Thursday, February 21, 2013 – 10am</td>
</tr>
<tr>
<td>Singapore</td>
<td>Director</td>
<td>Biotechnology company</td>
<td>Thursday, February 21, 2013 – 4pm</td>
</tr>
<tr>
<td>Chicago</td>
<td>Vice President</td>
<td>Biotechnology company</td>
<td>Tuesday, March 12, 2013 – 9am</td>
</tr>
<tr>
<td>Chicago</td>
<td>Assistant Director</td>
<td>Government office</td>
<td>Wednesday, March 13, 2013 – 3pm</td>
</tr>
<tr>
<td>Chicago</td>
<td>Director</td>
<td>University, Technology Transfer Office</td>
<td>Thursday, March 14, 2013 – 8am</td>
</tr>
<tr>
<td>Chicago</td>
<td>Vice Chancellor</td>
<td>University, Research division</td>
<td>Thursday, March 14, 2013 – 9.30am</td>
</tr>
<tr>
<td>Chicago</td>
<td>Senior Advisor/Entrepreneur</td>
<td>Science and Technology Organization</td>
<td>Friday, March 15, 2013 – 12pm</td>
</tr>
<tr>
<td>Chicago</td>
<td>Senior Vice-President/Biotech Company founder</td>
<td>Science and Technology Park Realtor</td>
<td>Friday, March 15, 2013 – 2.30pm</td>
</tr>
</tbody>
</table>
Appendix C. Online survey

1.

Welcome to the Cluster Networking and Management Survey!

The survey will take less than 20 minutes to complete. You may close and resume completion of the survey at any point. A completion of the survey within 7 to 10 days would be much appreciated.

All data collected in the survey is confidential and results will only be released in an aggregate fashion so that no individual respondent may be identified.

This global survey is part of a larger dissertation research project conducted by Sarah Giest, PhD Candidate in the Department of Political Science at Simon Fraser University, Burnaby BC, involving Dr. Michael Howlett as her supervisor. If you have any further questions please contact Sarah Giest by e-mail at sgiesl@sfu.ca.

Thank you very much for your participation!
2. Part I: Background Information

General information about the location of the cluster, the industry field and the structure of the network. This will be used to group the clusters into global regions and have a baseline for comparison.

[Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location]

1. I am located in...
   City/Town: 
   State/Province: 
   Country: 

2. I belong to the following stakeholder group:
   - company
   - cluster organization
   - [A cluster organization strengthens collaboration within the cluster and facilitates e.g. information exchange, training and seminars, joint corporation projects, marketing and public relations, as well as internationalization]
   - research institution/university
   - government department
   - technology transfer office
   - non-profit organization
   - Other (please specify)

   [Blurred text]

   [Progress buttons: Prev, Next]
3. Please rank the cluster organization's tasks from 1 (= very important) to 7 (= less important).

Note: Once you choose the first item, the services are ranked automatically. But you can edit the order by changing the numbers on the left. If the ranking still causes issues, you can also skip this question.

- Connecting cluster stakeholders to government
- Connecting stakeholders among each other
- Connecting the cluster to other networks
- Advertising the cluster on the (global) market
- Attract government funding
- Attract funding from venture capitalists
- Develop a strategy/plan for the cluster

4. The organization has been in place since...
   - under 1 year
   - 1-3 years
   - 3-5 years
   - more than 5 years
   - Don’t know

5. What kind of support is the cluster receiving?
   - Internal support
   - External support
   - Both
6. How does that internal support look like? (Please select all that apply)
   - collective financial pool
   - government-funding
   - seed capital
   - industry-funding
   - public-private partnerships
   - projects initiated by a government-funded institution
   - tax cuts
   - Other (please specify)

7. What kind of external support does the cluster get? (Please select all that apply)
   - venture capital
   - cooperation on foreign projects
   - skilled labour coming from other countries
   - university partnerships beyond the cluster
   - outside consulting
   - Other (please specify)

8. What kind of internal and external support does the cluster get? (Please select all that apply)
   - venture capital
   - cooperation on foreign projects
   - public-private partnerships
   - university partnerships beyond the cluster
   - outside consulting
   - government-funding
   - collective financial pool
   - tax cuts
   - skilled labour coming from other countries
   - industry-funding
   - projects initiated by a government-funded institution
   - Other (please specify)
9. What is the current **total employment** within the cluster?
   - less than 5,000 jobs
   - 6,000 to 10,000 jobs
   - 10,000 to 15,000 jobs
   - 15,000 to 20,000 jobs
   - 20,000 to 25,000 jobs
   - 25,000 to 30,000 jobs
   - over 30,000 jobs
   - Don’t know

10. What can you say about the **employment growth** in the last 5 to 10 years?
    - cutting jobs
    - below 5,000 jobs
    - less than 5,000 jobs
    - 5,000 to 10,000 jobs
    - 10,000 to 15,000 jobs
    - 15,000 to 20,000 jobs
    - 20,000 to 25,000 jobs
    - 25,000 to 30,000 jobs
    - over 30,000 jobs
    - Don’t know

11. What is the estimated **number of patents** the cluster has generated so far?
    - no patents so far
    - below 50
    - 50 to 150
    - 150 to 250
    - 250 to 350
    - 350 to 450
    - over 450
    - Don’t know
12. **What is the number of newly created spinoffs in the cluster?**

   [Spinoffs are new companies formed by one or more high-level, high-skilled employees who defected from a company in the same industry.]

   - no spinoffs
   - less than 5
   - 5 to 15
   - 16 to 25
   - 26 to 70
   - 71 to 150
   - more than 150
   - Don’t know

13. **What amount of funding in US dollars was raised by the cluster organization?**

   - below 10,000
   - 10,000 to 16,000
   - 16,000 to 30,000
   - 30,000 to 50,000
   - 50,000 to 100,000
   - 100,000 to 250,000
   - 250,000 to 500,000
   - 500,000 to 1 million
   - above 1 million
   - Don’t know

14. **How many significantly improved products, services or technologies were developed in the cluster so far?**

   - no improvements
   - below 5
   - 5 to 10
   - 11 to 15
   - 16 to 20
   - 21 to 35
   - 36 to 50
   - above 50
   - Don’t know
Which sector is the network mostly operating in?

[Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location.]

- Life sciences [e.g. biotechnology, genetics, health sciences, medical devices...
- Manufacturing [e.g. plastics, metallurgy and paper or wood products industries]
- Information Technology
- Environment [e.g. cleantech]
- Energy [e.g. wind energy, energy cogeneration (Biomass) or bio-energy conversion]

Other (please specify)

The name of the cluster or network is (if applicable)...
5. Part II: Networking within the cluster

Part II of the survey focuses on the networking among cluster stakeholders – specifically among universities/research institutions, industry and government. This includes, among other things, the communication structure and the type of relationship members have.

[Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location.]

17. What are forms of communication you use within the network? (Please select all that apply)

- [ ] via internet/intranet platform
- [ ] via email
- [ ] face-to-face
- [ ] regular/formal meetings
- [ ] irregular/casual meetings
- [ ] Other (please specify)

- [ ]

18. *How well do you think are stakeholders generally connected among each other?*

<table>
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<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>does not apply</th>
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<tbody>
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<td>personal connections among members</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>organizational ties among institutions' companies/ government</td>
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<tr>
<td>contractual links through a third party (e.g. technology transfer office, cluster management...)</td>
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</table>
### 19 How well do you think are university researchers connected to companies?

<table>
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<th></th>
<th>1 sporadic contact</th>
<th>2 seldom and irregular</th>
<th>3 irregular</th>
<th>4 regular</th>
<th>5 frequent and regular</th>
<th>Does not apply</th>
</tr>
</thead>
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<td>○</td>
<td>○</td>
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<tr>
<td><strong>organizational ties among institutions/companies/government</strong></td>
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<td>○</td>
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<td><strong>contractual links</strong> through a third party (e.g. technology transfer office, cluster management...)</td>
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<td>○</td>
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</table>

### 20 How well do you think are companies connected to government officials?

<table>
<thead>
<tr>
<th></th>
<th>1 sporadic contact</th>
<th>2 seldom and irregular</th>
<th>3 irregular</th>
<th>4 regular</th>
<th>5 frequent and regular</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>personal connections among members</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>organizational ties among institutions/companies/government</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>contractual links</strong> through a third party (e.g. technology transfer office, cluster management...)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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</table>
21 How well do you think are government officials connected to university researchers?

<table>
<thead>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
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<td><strong>sporadic contact</strong></td>
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<td><strong>personal connections among members</strong></td>
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<tr>
<td><strong>organizational ties among institutions/companies/government</strong></td>
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<tr>
<td><strong>contractual links through a third party (e.g. technology transfer office, cluster management...)</strong></td>
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</table>

22 Is there a cluster organization/manager facilitator in place?

[A cluster organization strengthens collaboration within the cluster and facilitates e.g. information exchange, training and seminars, joint corporation projects, marketing and public relations, as well as internationalization]

- Yes
- No
- Don't know

43%
23 * How long have you known of the cluster organization?
   - less than a year
   - 1-3 years
   - 3-5 years
   - more than 5 years
   - Don't know

24 * What services that you know of are currently provided by the cluster organization for your organization? (Please select all that apply)
   - presentations on current research
   - networking meetings
   - advertising of the cluster on the (global) market
   - communication platform
   - advice on funding opportunities
   - creation of funding opportunities
   - attraction of venture capital
   - connections to other clusters/firms/research institutions
   - support of entrepreneurs
   - creation of new projects for cooperation

Other (please specify)

270
25 Please rank the services provided by the cluster organization. Rank them according to their level of importance for your organization from 1 (very important) to 10 (not important).

Note: Once you choose the first item, the services are ranked automatically. But you can edit the order by changing the numbers on the left. If the ranking still causes issues, you can also skip this question.

- presentations on current research
- networking meetings
- advertising of the cluster on the (global) market
- communication platform
- advice on funding opportunities
- creation of funding opportunities
- attraction of venture capital
- connections to other clusters' firms' research institutions
- support of entrepreneurs
- creation of new projects for cooperation

26 How has the work of the cluster organization affected your networking in the cluster? (Please select all that apply)

- better/stronger connections to cluster stakeholders
- better/stronger connections to stakeholders in other clusters
- more government attention (e.g., in form of a policy document or funding)
- more meetings among stakeholders
- more interest from venture capitalists
- more researchers staying/coming into the cluster
- more spin-offs [spin-off company is a new business entity formed to commercialize one or more related inventions generated from the research work from a parent institution]

Other (please specify)
7. Part III: Networking beyond the regional cluster

Identifying the connections that stakeholders have beyond the local network, helps to understand where potential funding and knowledge is coming from and who engages in those extra-cluster relationships.

[Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location.]

27. Are you in contact with stakeholders (e.g., research institutions or firms) from other regional industry clusters?
   - Yes
   - No
28 Who are you in contact with?
- university/research institution
- research department from another company
- branch of our own company
- government officials

29 Do those outside-network linkages provide valuable information for work within the cluster?
- Yes
- No

30 How would you rate your network members' overall connection to other clusters?

(Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location.)

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[67%]
9. Part IV: Policy and Strategy for the cluster

Part IV targets the current policy, legislation and set-up of the cluster. This includes how well some government-initiated regulations are working for members of the network and which elements of the cluster are specifically targeted by it.

[Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location.]

31  Do you know of a government policy document targeting your industry cluster specifically?
- Yes
- No
- Don’t know
Other (please specify)

32  Which legislation, regulation or policy acts as incentive for cluster development?
- the university system
- immigration legislation
- housing policy
- infrastructure policy
- tax reductions
- the education system
Other (please specify)

33  Please select the legislation, regulation or policy that poses a barrier to cluster development.
- immigration legislation
- housing policy
- infrastructure policy
- tax reductions
- the education system
- the university system
Other (please specify)
What would be successful government programs that could support the network? (Rank the answers, from 1 = very important to 7 = less important)

Note: Once you choose the first item, the services are ranked automatically. But you can edit the order by changing the numbers on the left. If the ranking still causes issues, you can also skip this question.

- □ direct funding
- □ project-based funding
- □ funding through a third organization
- □ educational funding
- □ competitive grants
- □ infrastructural funding (e.g., supporting a cluster organization)
- □ no government involvement

38. * Does your cluster have or are you a successful firm (anchor firm) that draws in investors?  
   - □ Yes  
   - □ No  
   - □ Don't know

39. * Does your cluster have a famous scientist (star scientist) drawing attention towards the network, which leads to more funding?  
   - □ Yes  
   - □ No  
   - □ Don't know
10. Part V: Evaluating the network

This part of the survey looks at how the cluster is evaluated and how well it performs compared to other networks.

[Clusters are defined as densely linked companies, research institutions and government departments in a common industry and the same location.]

40. How are achievements by you and other stakeholders evaluated? (Please select all that apply)
   - project-based evaluation
   - cluster-wide evaluation
   - firm-based evaluation
   - industry report
   - no cluster evaluation
   - don’t know
   Other (please specify)

41. How often do you see evaluations taking place?
   - more than once a year
   - once a year
   - every 2-3 years
   - every 3-4 years
   - every 5 years
   - less than every 5 years
   - never
   - Don’t know

Other (please specify)
42. Who evaluates the performance of the overall cluster? (Please select all that apply)

- Government
- Cluster organization
- Internal (consulting) company
- External (consulting) company
- External organization (e.g., European Union)
- University
- Don’t know
- Other (please specify)

43. What do you think makes the cluster successful or what would make it more successful? (Please select all that apply) [Clusters are defined as densely linked companies, research institutions, and government departments in a common industry and the same location.]

- Government involvement/plan
- Amount of funding by internal sources
- Amount of funding by external sources
- Cluster organization/management
- Networking among stakeholders
- Competition among stakeholders
- Innovative research
- Other (please specify)

44. How strong is the culture that encourages new ideas resulting in a business (entrepreneurial culture) in your cluster?

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<th>1 (very weak)</th>
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<tbody>
<tr>
<td>Entrepreneurial culture</td>
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45. How would you evaluate the cluster's competitiveness?
   - considered the world's strongest
   - among the world's 3 most competitive
   - among the world's 10 most competitive
   - internationally significant
   - nationally significant
   - weak
   - noncompetitive
   - emerging
   - Other (please specify)

12. Additional comments

   If you have anything to add or a comment to make about cluster management or policy in general or about the survey in particular, please do so in the box below (100 characters):