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Title

Capacity-building through network management: Cluster facilitators as procedural tools

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INTRODUCTION

Governments around the world struggle to support the globalized learning economy (Archibugi & Lundvall 2001). In a time when the exchange of ideas and the networking among stakeholders has become crucial for economic growth of some regions, policy has not found the right tools to support and enhance those dynamics. This is connected to two things: First, there is no systematic analysis of what industry networks across sectors need, and second, the tools that are currently in use are not evaluated properly, which means some of them might be successful, but due to missing proof of their effect no other governments can learn from this experience. The paper focuses on a specific procedural tool in the context of industry cluster policy: the implementation of a cluster facilitator. Clusters are defined as densely linked companies, research institutions and government departments in a common industry and in the same geographic location. They bring some specific challenges to government policy tools. First, they prosper in research-intensive environment, which means supporting, attracting and retaining researchers is one crucial aspect of successful policy. Second, the challenging need for continuous new business formation to keep up the momentum for creating employment and attracting venture capital. And the third challenge is probably the most important one: the ongoing networking among cluster stakeholders and between stakeholders and government officials (Karaev et al. 2007; Porter 1998). However, governments need new procedural tools to address such complex networking dynamics.

Procedural instruments, as opposed to substantive ones, have a less direct impact on policy outcomes. Rather than affect the delivery of goods and services, their principle intent is to modify or alter the nature of policy processes at work in the implementation process (Howlett 2000; in't Veld 1998). In connection to cluster management, the idea is that a facilitator as one instrument cannot only enhance capacities for all stakeholders involved – government, industry and research – but also has more leeway and opportunities in applying certain strategies in a way a government could not. At the

same time it frees-up space for government in fulfilling more architectonical functions. Intermediary institutions are also able to establish higher levels of collaborative and absorptive capacity. Collaborative capacity entails purpose, communication, structure, and resources. Absorptive capacity, compared to collaborative capacity, focuses on the ability the cluster '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). All these elements are crucial for a network or cluster to connect multiple stakeholders (Lai 2011). *The paper hypothesizes that establishing a cluster facilitator leads to higher levels of interagency collaborative capacity (Agranoff & McGuire 2001) and ultimately to better economic performance.*

NETWORK GOVERNANCE

Governments are facing new challenges in form of more complex problems related to high-tech industry networks and the way they are governed. Achieving common goals, such as higher levels of innovation, is not purely the result of the invisible hand of the market or the visible hand of government anymore. The focus has shifted towards 'reciprocal gains that can be achieved in explicit agreements of more or less independent actors and their relationships' (van Dijk & Winters-van Beek 2008, 8). In this set-up, the idea is to have the combination of horizontal and vertical control and coordination (de Sanctis & Fulk 2000) while aiming for a more flexible organizational form of network governance (Torfing 2005; Hajer and Versteeg 2005; van Dijk & Winters-van Beek 2008; Rutter et al. 2012). Network management and network governance research has shown that the role of government has changed, especially in innovative and fast-moving industries, to the point that decision-makers must choose between different governance mechanisms or combine the right ones (Torfing 2005; de Sanctis & Fulk 2000; van Dijlk & Winters-van Beek 2008).

First, due to uncertainty and new forms of risk connected to complex policy problems, there is a growing demand for knowledge-based decision-making. Network governance is a mean to address this

issue by involving 'intermediary groups and actors' (Torfing 2005). The paper looks at the option of an 'arm's length organization' being such an actor to manage the network, while government operates from a distance (Rutter et al. 2012; Kickert et al. 1997). In the context of high-tech networks, governing from a distance means that government retreats to creating favourable conditions through indirect measures such as tax incentives, education and immigration policy as well as patent laws or basic research funding. The advantage of choosing the additional management tool as a mechanism to govern is the creation of favourable conditions for cooperation within the industry. It also poses a much more targeted approach in the sense that experts with a certain skill-set are in charge managing the network (Rutter et al. 2012). This meets the demands of highly-specialized networks that are dominating the high-tech sector. Unilateral steering usually does not work very well for such complex networks and problems that arise from them – 'that is, problems involving many actors and considerable uncertainty about knowledge, as well as disagreement about what the problem is and what the best solutions are' (Klijn 2005, 331-332). Finally, the need for vertical and horizontal coordination challenges government. A cluster management actor can provide this in a much more far-reaching sense that government ever could. A manager or several mangers are closely connected to the key stakeholders in a network (horizontal), while keeping in touch with the multiple levels of government involved, including local, regional actors as well as the national government or even the European Union and other global players (vertical).

In sum, the theoretical analysis shows that there has been a shift in the way government positions itself, mainly focusing on networking for complex and uncertain problems and the idea of network management as one tool to foster the underlying cooperation capacities that enhance the performance of such networks.

NETWORK 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. Important aspects for the use of second-generation instruments include that they require actors who govern and function as mangers to deploy instruments in a way which differs from the traditional approach (De Bruijn & Ten Heuvelhof 1997).

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 the 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).

Embedded in the evidence-based public management view, the paper aims to identify management techniques that work in practice and are connected to government and industry alike through the intermediary facilitator. 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). The 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).

In sum, *the cluster facilitator is the tool and entry-point for government to impact the cluster internally. The implementation of the facilitator helps in identifying strength and weaknesses of the cluster and tying together the key stakeholders through a cluster vision and mission in the field*. The mechanism behind the connection between the a network management tool and performance is the level of collaborative and absorptive capacity.

CLUSTER MANAGEMENT ENHANCING COLLABORATIVE AND ABSORPTIVE CAPACITIES

Analyzing cluster management activities through the lens of the collaborative and absorptive capacity concepts reveals their connection to cluster performance. 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. He hypothesizes that without collaborative capacity in place, managing networks among multiple stakeholders is unlikely to succeed. Lai 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. 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 thus knowledge exchange and innovation levels.

Absorptive capacity, compared to collaborative 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). The original concept is again based on firms that 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 2005:269). 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 has the knowledge base to pick and distribute information. The intra-cluster knowledge system consists of the learning and collaboration processes between stakeholders.

Absorptive capacity is also cumulative. This means that investing and fostering elements that contribute to the capacity 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 understands which information is still missing 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 hopefully benefit the organization or network (Buenstorf & Murmann 2005; Harvey et al. 2010; Lane et al. 2006). With a wider knowledge basis, the expectation also is that the network is prepared for changes and has better foresight of how to meet future challenges.

van den Bosch et al. (1999) highlight the overall development of coordination capabilities. They describe it as the ability to engage in flexible knowledge exchange and generation across hierarchy and functions, as well as formalized methods of codifying, communicating and integrating knowledge through policies, procedures and manuals (van den Bosch et al. 1999; Harvey et al. 2010). Both, the collaborative and the absorptive capacity framework enable to name activities that enhance growth and productivity within a cluster. 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).

This is where the paper sees an entry point for government to facilitate performance. A designated network manager would support and service the collaborative and absorptive capacity of the network to ultimately create higher performance levels. Such a leader could be directly implemented by government or established over time by stakeholders in the cluster. From a government perspective, this could be an additional – very important – tool in the toolbox, while still developing policies that contribute to the success of the network.

METHODOLOGY

The analysis in the paper bases on three case studies in Vancouver (Canada), Medicon Valley (Denmark/ Sweden) and Singapore as well as a global survey, combining qualitative and quantitative methods. Stakeholders were targeted according to the triple-helix structure, which consists of research

institutions, government departments and companies (Etzkowitz 2003). The independent variable of cluster management is measured by the proxies of the absorptive and collaborative capacity frameworks. The concepts pose the common ground among cluster management in different sectors and circumstances. Also, 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. The capacity frameworks also make the connection to overall growth as studies support the view that one or more of the above-mentioned dimensions of the absorptive or collaborative capacities of a cluster are related to its growth trajectory (Giuliani 2005; Giuliani 2003; Mytelka & Farinelli 2003; Cohen & Levinthal 1990, Baptista 1998; Mathews 2002). Employment, innovation and productivity define the dependent variable of performance. Together these indicators show the relationship between using cluster management and higher performance in networks, which makes the implementation of a cluster facilitator a valid tool for supporting industry networks (see Figure 1).

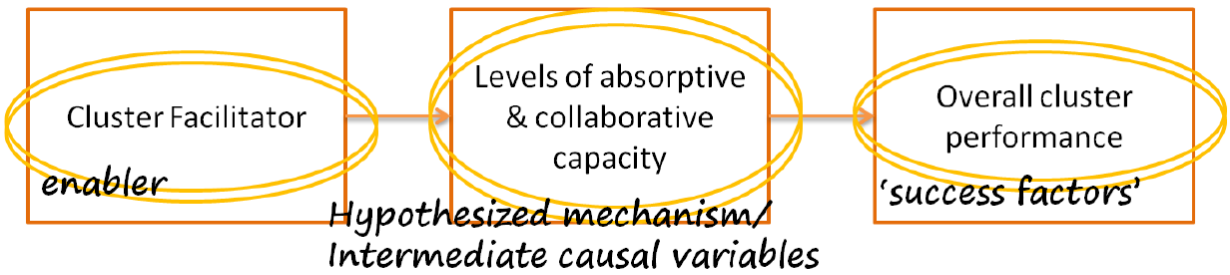

Figure 1. Hypothesized relationship between the cluster management tool and performance.

The cases were chosen based on the degree of government involvement and cluster management. In Singapore, government involvement in terms of funding and organizing the life science network is high. This is true for most Asian countries, as they are trying to fast-track the high-tech industry development in their countries. 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. Vancouver (Canada) has less government involvement – besides the healthcare field. This means it relies on an entrepreneur-driven culture, without overarching management attempts. This is also reflected in many US clusters. Information on all cases was gathered through semi-structured interviews with officials from government, research institutions and industry.

The findings from this diverse set of cases are complemented by a survey that targets mostly life sciences, but also manufacturing, ICT, energy and environmental clusters around the world. It is set-up to capture the different elements of collaborative and absorptive capacity, by contacting cluster management organizations themselves, industry, research and government stakeholders. The results from the survey are preliminary, as responses are still being collected.

CASE STUDIES

Vancouver, Canada

The British Columbian 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 2012). 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 the BC biotech network, stakeholders currently 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 to the network, but not all of it is effective. Genome BC, for example, is a major investor focusing on furthering the tool 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. Thus, provincial investment is crucial to projects supported by Genome BC. This includes the ability to gather human resources for projects by bringing together the right stakeholders. This resource position is of course limited to the extent that genomics is a small part or tool of an increasingly broad spectrum of life sciences. And second, they are tied to government in leveraging provincial and federal funds, which makes cooperation with industry difficult. Especially government-funded programs are subject to restrictions, such as that money has to stay in BC and caps on how much one project can receive or specifications on program participants. The research-focus of most programs is also mostly not tailored towards industry needs. For government support that is not channeled through Genome BC or Genome Canada, stakeholders from the BC network highlighted the following programs:

- 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).

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 BC Knowledge Development Fund (BCKDF) and regionally by Western Diversification Canada (WD). To the provincial research community, such as UBC, the office offers services, such as internal reviews of funding applications, post-award workshops, financial and strategic support. Overall BCKDF and WD provide infrastructure 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.

The last government-driven element that was highlighted in the interviews is the National Sciences and Engineering Research Council (NSERC). The agency 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 money to support collaborations between industry and academia. This funding is at the national level though, so the amount that comes into BC is somewhat unpredictable. On top of that, there is the scientific research and experimental development tax credit, which is not targeted at 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 is also one of the major criticisms within the BC cluster: '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. 2011:4-2). From the perspective of firms in BC, 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.

Another issue is the above mentioned unpredictability of government funding. In other countries, for example Germany, there are 20 to 30 year horizons of planning, whereas Canadian planners seem to be more focused on shorter-term periods of 2-5 years. BC has also seen peaks of funding into different sectors and some of the money and the way it is spent comes and goes over time. This would not weigh as heavy if there was venture capital to back up the BC network, but as one interviewee put it: 'the Canadian system is like a desert in terms of venture capital'. He further states that there is no venture community, especially new venture capital within BC. 'We used to have arguably 14 firms; we are now down to a few. There is no more financing, there is only follow-ons'. This means that there is predominantly serial uptake: one group has an engagement and then another and another, without new investors coming in to support other projects in BC. This does not mean that there is no capital coming in from the outside – the US for example – but the danger is that those investments lead to venture capitalists that are only interested when there is a product that will be developed in a very near term at minimum risk – something that is unlikely in the life sciences sector – or sellable in the US or even linked to the expectation that the company would relocate south of the border.

Enhancing coherence within the cluster in terms of purpose, communication and structure could go a long way in focusing life sciences research in BC. This is especially needed since an anchor company cannot be created in a quick fix and even in the long-term BC or Vancouver will never have the critical mass of European or American cities that often cross sectoral or national boundaries for research and commercialization purposes. And research as well as most commercialization can be done anywhere in the world today. 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 better management of networking processes for furthering life sciences is critical in this province.

Medicon Valley, Denmark/Sweden

The multi-level governance structure and policies affect the local process of industrial clustering in Denmark and Sweden. As the following section will show, the interviews conducted in the Medicon Valley with high-ranked officials from university, industry, government and the Medicon Valley Alliance reveal that different groups have different expectations of what the role of government should be and which policies best support the biotech cluster.

Overall, many obstacles and boosts of cluster competitiveness originate directly or indirectly from national policies: '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 2009, 30). National government changes have also affected regional initiatives for clustering through 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 2011, 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. Adding another level to European, national and regional governance of cluster development is the Medicon Valley Alliance (MVA). This organization 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.

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. 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.

Day-to-day activities by MVA 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 the university giving a scientific talk about new developments in a certain sub-field of biotech with firms present or a form or 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 the connecting of companies to a 'talent pool within Denmark and Sweden – for example at

universities – but also outside through the ambassador program[1]'. 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, they are using the fact that there are so many 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 product by matching researchers and firms or firms and firms. 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'.

The fourth activity is what MVA calls 'smart specialization', where they focus on specific areas in which the cluster has an advantage and then specifically support this.

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

[1] The MVA Ambassador Program is a Medicon Valley Alliance initiative aiming to assist life science organizations in Medicon Valley in building international partnerships and business connections. This is done by posting Ambassadors in regions of relevance to the life science sector in Medicon Valley. Currently, MVA 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'.

multiple levels, facilitating connections among them as well as integrating 'local buzz' and 'global pipelines' (Wolfe & Creutzberg 2003).

Singapore

Singapore has been ranked the most innovative country in Asia last year (2012). It was also ranked first for its innovation capabilities, due to a well-trained workforce, a robust research community and sophisticated financial markets. Globally, Singapore was placed just below the European nations of Switzerland and Sweden in the 2012 Global Innovation Index. However, while Singapore has done well in terms of innovation input, output results place the country 83rd globally. This means that Singapore has invested significantly to create the most conducive environment for innovation, but 'the output results of these efforts have come in below expectations' (Khuan 2012).

Starting out with the input initiatives, Singapore established a policy for creating high technology industrialization in the late 1970s. This led to closer relationships between private companies and government departments and generally to a heightened interest in improving productivity (Pugh 1986). This push for new technologies was connected to the decline in the manufacturing industry and the fact that Singapore lacks natural resources (Wan, Ong & Lee 2003). A big wave of investment followed in the 1990s, when several large companies including Schering-Plough and Novartis built manufacturing sites. In 2000, a more specific strategy was launched by government, targeting drug discovery and biotechnology. The goal was – and still is – to attract big (pharma) companies to the country. The government hopes that with big names and anchor companies, smaller firms will follow.

Further, as a visible commitment to the life science industry, Singapore built two state-of-the-art biomedical research parks. 'Biopolis' 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 (A*STAR 2009). The Genome Institute of Singapore and the Bioinformatics Institute were some of the first tenants to move into the high-rises called Centros, Matrix, Genome, Nanos, Proteos,

Chromos or Helios. The second complex built to house research institutes is 'Fusionopolis'. Fusionopolis tenants focus primarily on engineering research. Together, Biopolis and Fusionopolis are strategically co-located at 'one-north'. Beyond these two hubs created by government, many firms also settled into the 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. The state-of-the-art facilities and the funding commitment by government also attracted star scientists to Singapore over the years. 'Alan Coleman, co-creater of Dolly (the cloned sheep) has relocated his research to Singapore. So have Sir David Cane, discoverer of the p53 cancer gene and Edison Lin, the former Director of the US National Institute' (Ali 2006).

The main driver of these developments in life sciences is government. Singapore has made investment, infrastructural and strategic commitments to the industry; hence the high-ranking position on the innovation input side. Key stakeholders are the Biomedical Science Group of Singapore's Economic Development Board (EDB), Bio*ONE Capital and the Agency for Science, Technology and Research (A*STAR). A*STAR, the former National Science & Technology Board, is a statuary board under the Ministry of Trade & Industry. It basically is a R&D funding body and a 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.

The Economic Development Board (EDB), as a government agency, is responsible for the outward visibility and connections of the cluster. Many of the interviewees emphasized that they met people from the EDB in other countries before and for some, this is where they were recruited. The EDB is represented in 12 key locations around the world to facilitate partnerships, including several locations in China, France, Germany, Sweden, UK or 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. Bio*ONE capital is the corporate

investment arm of the EDB and manages funds connected to life sciences. This puts investment decisions into the hands of experts in the field, instead of government officials.

In terms of collaborative and absorptive capacities, A*STAR plays the key role in facilitating networking among stakeholders inside and outside of the cluster. One aspect that stood out during the interviews concerning cooperation was the recent effect of the change in funding. For some of the research institutes, all the funding used to come directly from A*STAR in five-year chunks. Thus, when meeting performance targets and while being in connection with A*STAR, every five years, new and often more funding would be provided. Today, for institutes such as the Singapore Immunology Network (SIgN), 75% of the funding is provided by A*STAR, while 25% has to be attracted through collaborative projects with other institutes or preferably industry. According to some stakeholders this also encouraged institutes to sell some of 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.

To specifically enhance cooperation among research and industry, A*STAR also created 'Exploit Technologies', a technology transfer institute under its leadership. Exploit Technologies is meant to be an industry-research interface, in which teams of technology transfer professionals harness new technologies, increase the value of intellectual property and incubate business ventures to create commercial impact. Building the mentioned hubs, Biopolis and Fusionopolis, also caters towards the vision of a collaborative ecosystem that is in close geographic proximity.

In this sense, A*STAR clearly funds, structures and provides the strategic vision for the cluster. It is obvious, that all these activities are also predominantly geared towards the applied side of life sciences. According to stakeholders in the cluster, this has to do with the close relationships between A*STAR and the EDB and EDB's vision to build a track record of successful commercialization and the goal to leap frog to a higher spot in the global competition in terms of commercialization.

Related to absorptive capacity, as mentioned before, the EDB has locations around the world to connect to experts, industry and top researchers. Also, A*STAR or rather its research institutes have close relationships with departments in Boston and Stanford, which fosters knowledge exchange and they are also used as entrepreneurial incubators. In terms of tapping the knowledge and opportunities of other clusters, A*STAR identifies and funds 'home-grown' and outside talent to either come to Singapore or train in high-ranked institutes outside the country. In fact, the current scholarship program is geared towards Singaporeans that are willing to come back home after their education in another country is paid for. This reduces the risk of brain drain and increases the amount of human capital.

Overall, what we see on the input side of innovation in Singapore is that the framework and administrative structure is geared towards sector specialization (Kumar & Siddique 2007). Government spun the network strategically by setting out a plan and acted on it. The key is the partnership model between Singapore's lead agency, A*STAR and the public and private sector. 'This partnership links basic and applied research and cuts across traditionally separate disciplines, serving as an engine for economic growth' (Nature 2011). The government is aiming to continue down this path, securing an S$16.1 billion (US$12.9 billion) in research and development for 2011-2015, which represents a 20% increase over the previous five years (Nature 2011).

However, the set-up of innovation input initiatives masks some of the difficulties seen in commercialization. As mentioned earlier, the translation of the amount of funding into applications has been rather slow. During the interviews with officials from A*STAR, research institutes and industry, three issues stood out. First, the investments apply to a broad range of research, which means Singapore is currently 'betting on many horses', but has not found its niche or competitive advantage in the field yet. This makes it difficult to focus on one area and also for companies to identify where the industry is heading. However, this is bound to change, as A*STAR gave out S$70 million (US$56.6 million) to stem cell research alone – a big amount compared to the number of researchers working in

the field. Several interviewees also identified stem cell research as an area where Singapore could become competitive.

Second, there is currently a discussion about the aggressive shift by A*STAR from funding basic research to pushing the applied side of life sciences. This has mainly to do with cutting 25% of the funding for some research institutes in favour of possible industry collaborations. One stakeholder pointed out that if he would have to find another 5% beyond A*STAR support, the institute would not survive. Singapore as a young cluster compared to other life science hubs, is still 'heavily driven by risk-averse academics and government-funded scientists' (Lee 2012). However, A*STAR knows that industry is only interested in coming to Singapore when a solid R&D base is established and a credible talent pool can be found.

The available talent pool is the third issue especially the applied institutes and companies are struggling with. According to some interviewees there seems to be a gap between junior and senior researchers or more generally speaking between routine work and the management positions. Leading positions, as I experienced myself when talking to directors, CEOs and Vice-Presidents, are often in the hands of foreigners, so-called 'expats'. They come in for a couple of years and then leave without having someone from Singapore to fill their position. Also, people often only stay with one company or research institute for some years, even if they are not leaving the country. Thus, retaining talent is a difficult endeavour and it seems that attracting it is also becoming more difficult. Living expenses – especially housing – has gone up and firms are nowadays reluctant to cover those costs for their foreign employees. Also, an immigration discussion[2] has just recently erupted in Singapore about the

[2] The city-state currently has a population of 5.3 million, and is now more densely populated than Hong Kong. Under a government white paper – which was approved in February 2013 despite widespread public anger – Singapore will aim to increase its population to 6.9 million people over the next 20 years by granting permanent residency to 30,000 people and allowing an inflow of some 25,000 new citizens every year. New social programmes, including marriage and parenthood initiatives, as well as infrastructure schemes, will accommodate the burgeoning population, with immigration calibrated to retain its current ethnic ratios. However, skyrocketing housing prices, overcrowding, long working hours, low birth rates and an ageing population – that the government terms Singapore's "silver tsunami" – are all major contributors to discontent. (Hodal 2013)

number of immigrants in the country and the effect on the local population. It might be that Singapore starts losing some of its appeal and will have a human capital problem in the future.

CONCLUSION: NETWORK GOVERNANCE WITH A CLUSTER MANAGEMENT TOOL

Generally, industry stakeholders in all three clusters showed reluctance towards government involvement in innovation. But going beyond the 'no government mantra' of most companies, it seems that government intervention can also be used to encourage innovation by promoting innovation-friendly policies, resolving bottlenecks and facilitating the network, as shown in two of the three case studies (Anthony, Roth & Christensen 2002). This is supported by the survey results[3], which show that especially the university system, infrastructural policy and the education system act as incentives for cluster development (Figure 2). For example, increasing the availability of resources (raw materials, capital and human capital) is a way to encourage the creation of more innovative products and services.

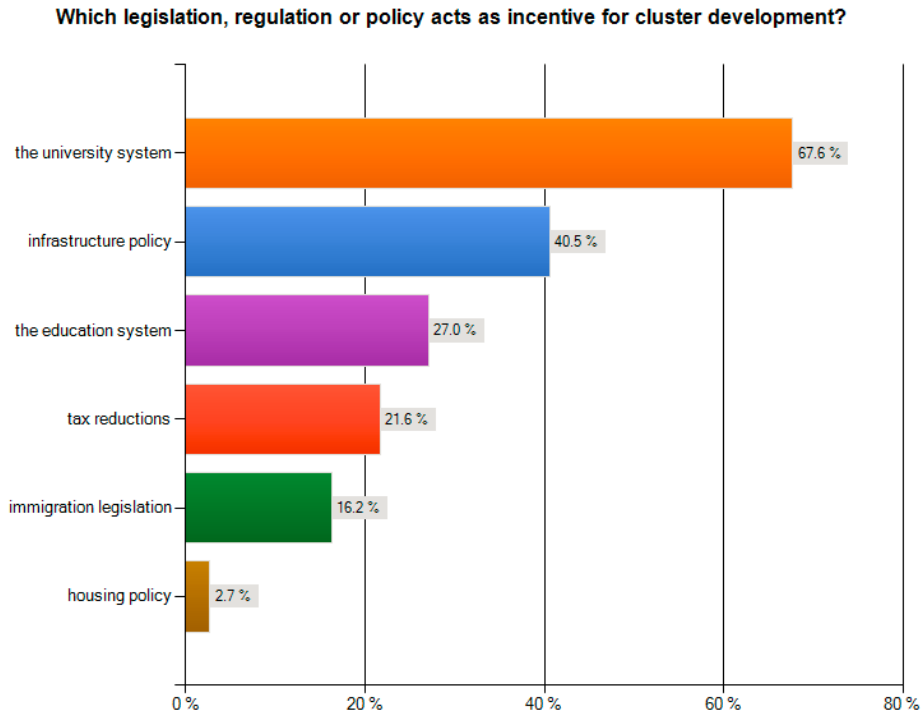

Figure 2. Incentives for cluster development.

[3] The online survey targets ~1400 stakeholders of life science, energy, ICT, environmental and manufacturing clusters around the world with a structured questionnaire of about 30 questions. So far, the response rate is at 8.2%.

These mixed signals towards government policies for innovation networks show the current transformation in most countries towards network governance. It further highlights the dependency between stakeholders and government and the need for a link between them. Both of these issues are visible in the case studies and the survey. Conventional unilateral steering does not work for a network set-up and the market is unable to create all favourable conditions on its own. Further, network management requires knowledge of the cluster and numerous skills (Klijn 2005). This implies that government in general has to be more open about including private actors into their decision-making process, as problems surrounding innovation tend to be complex and more general policy changes in e.g. immigration policy could have severe consequences on industry and research. This creates a situation 'where policy problems have to be tackled in networks of interdependent organizations both public and private' (Klijn 2005, 328).

This form of governance combines horizontal and vertical control and coordination as former state powers stay in place while adding new capacities on both sides (Torfing 2005; van Dijk & Winters-van Beek 2008; de Sanctis & Fulk 2000; Pierre & Peters 2000). Taking this development one step further, is the idea of a network management entity that possesses the skill-set to facilitate the cluster while being in close relationship with government. Posing – besides all network management responsibilities – as a communication channel between government and stakeholders. The survey reflects this by showing that when network management is in place, it encourages stakeholders to connect and meet with each other and also brings them more government attention for e.g. funding opportunities (Figure 3).

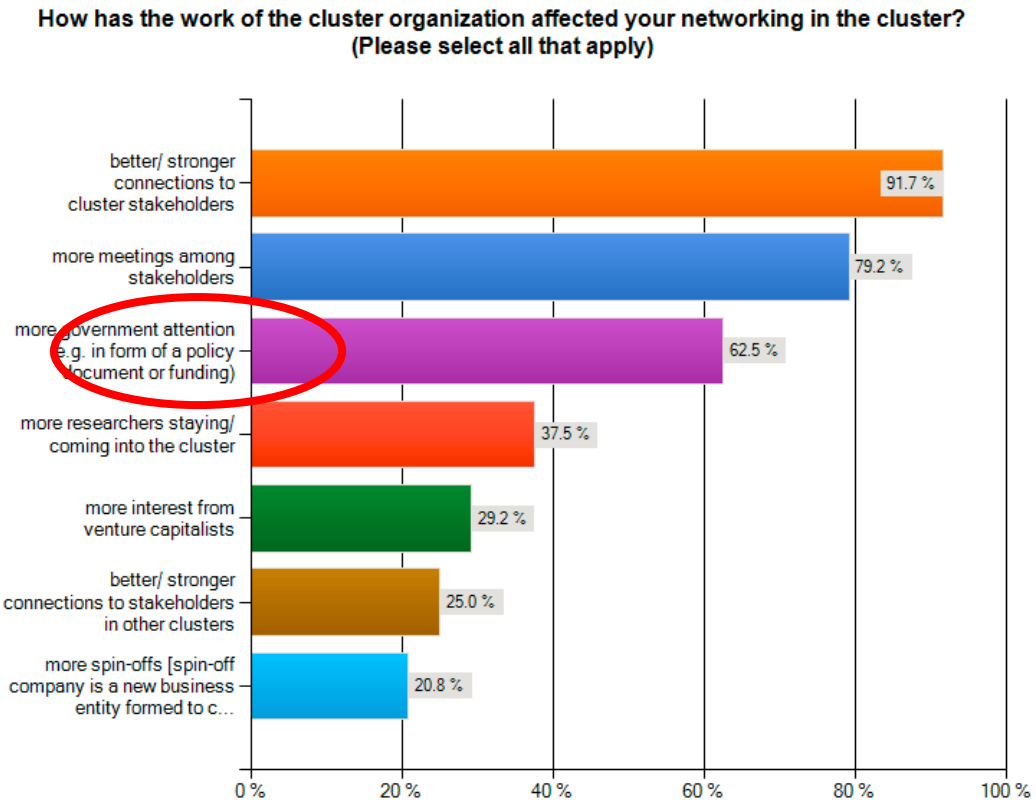

Figure 3. Effects of cluster organizations.

In more detail, this dynamic also presented itself in the case studies, where either there was no real relationship with government without the network manager (Vancouver, Canada) or an interactive relationship through an organization such as Medicon Valley Alliance (Denmark/ Sweden). In Singapore, the situation is a little different, since the one managing the cluster, A*STAR, is also a government entity. However, they were able to reach out to research institutes and private stakeholders and combine both vertical and horizontal elements.

The cases also indicate that there is a connection between having a cluster manager and the levels of collaborative and absorptive capacity. But does that also – in a second step – affect performance? Preliminary results from the survey suggest exactly that: 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 4).

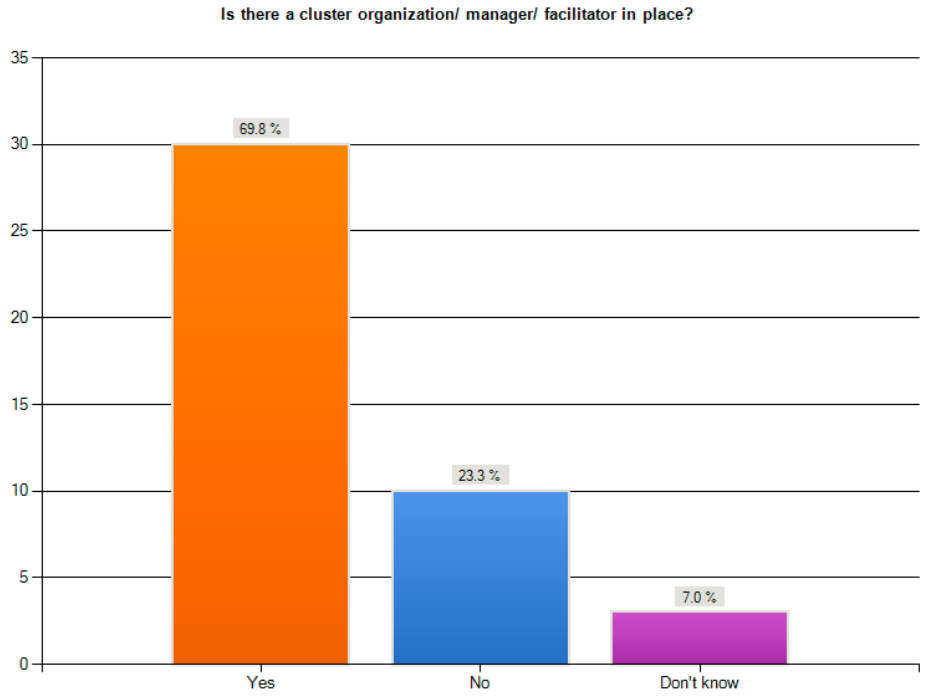

Figure 4. Existence of a cluster organization in competitive clusters[4].

These results have to be interpreted with extreme caution though, 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 always seems to be an organization with a management function which also poses an entry point for government. If further research can support this claim and prove that this is a generalizable trait, governments can actively pursue cluster organizations as tools to facilitate high-tech clusters and make informed decisions about related policies, such as tax incentives or the education system.

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[4] 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'.

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