



Munich Personal RePEc Archive

The governance of Singapore's knowledge clusters: off shore marine business and waterhub

Menkhoff, Thomas and Evers, Hans-Dieter

singapore management university, CenPRIS, Universiti Sains
Malaysia

16 September 2011

Online at <https://mpra.ub.uni-muenchen.de/33979/>
MPRA Paper No. 33979, posted 09 Oct 2011 13:48 UTC

The Governance of Singapore's Knowledge Clusters: Off Shore Marine Business and WaterHub

Thomas Menkhoff

(with research assistance by Gabriel Yee)
Lee Kong Chian School of Business
Singapore Management University

and

Hans-Dieter Evers

Centre for Policy Research and International Studies (CenPRIS)
Universiti Sains Malaysia

Abstract

Based on two case studies of knowledge clusters (off shore marine/rig business and water hub) in Singapore, the paper illustrates the importance of good knowledge governance in creating robust and value-creating knowledge clusters. We begin by defining key terms used such as knowledge clusters, hubs and governance, followed by a short historical account of good knowledge governance for Singapore's development. The two cases studies of knowledge clusters presented here include (i) the offshore oil rig business (Keppel) which we posit as an example of innovative value creation based on sophisticated fabrication methods and R&D as well as (ii) the island republic's dynamic and rapidly emerging, global hydrohub called 'WaterHub'. We examine the structural characteristics of both clusters, assess their progress based on the cluster lifecycle literature, highlight key governance enablers required to create and sustain such competitive hubs and draw conclusions for K4D latecomers.

Keywords

Knowledge governance, knowledge clusters, science policy, Singapore

Introduction: Economic Success Through Good Knowledge Governance

A key element of the Singapore success story as an economic powerhouse and knowledge city (Carrillo 2004; 2006) is the skillful deployment of good *knowledge governance* and associated strategies by policy-makers and leaders in government and business aimed at creating sustainable *knowledge clusters* with dynamic *knowledge hubs* (Pinch et al. 2003). Due its robust knowledge eco-system, Singapore has been identified as a role model by multi-lateral development agencies such as the Asian Development Bank (ADB) or the World Bank to inspire latecomers in the knowledge race in the context of knowledge for development programs (K4D). In this paper, we will present brief analyses of two knowledge clusters in Singapore aimed at identifying some of their specifics in terms of structure, knowledge governance and performance-related outcomes to provide lessons learnt for Asian policy-makers and leaders interested in leveraging on knowledge for development (Evers 2011).

Definitions

We coined the term 'knowledge governance' in line with the discussion about good governance as one important enabler of the rise of the Asian growth economies (Evers, Gerke, Menkhoff 2011; Menkhoff et al. 2010). *We define and conceptualise **knowledge governance** as both a managerial-administrative process and a structure of authority relations*; it involves the channelling of resources in building up knowledge management capabilities and improving the competitive advantage of a country in the world market by utilizing knowledge as a factor of production. Knowledge governance refers to the multiple tasks and capabilities of governmental units in embedding and creating appropriate institutions to leverage on *glocal* knowledge – from establishing high quality primary schools to the codification of national ICT plans aimed at creating a knowledge-based economy (or as in the case of Singapore - an 'intelligent nation') and the effective management of foreign talent. Relevant governance factors in the Singapore Inc. case include the high steering power and efficiency of government, state and knowledge elites as well as outstanding planning and organising competencies of units tasked with realizing

national KBE goals. Examples of significant plans include the Strategic Economic Plan (1991) with cluster development goals for the manufacturing sector and services; the IT 2000 Plan (1992) aimed at developing national Internet-Broadband network; the Industry 21 (1999) with focus on knowledge-intensive sectors and the various Science & Technology Plans; or the Intelligent Nation Masterplan iN2015. All these plans were instrumental in achieving the vision of policy-makers aimed at (i) systematically creating knowledge hubs, competence centres and centres of excellence, (ii) developing knowledge clusters as learning regions, (iii) transferring knowledge to stakeholders in civil society, government and business, (iv) acquiring knowledge through global producer networks and (v) utilising glocal knowledge to build comparative advantages in niche areas (Menkhoff et al. 2011).

Prominent knowledge clusters in Singapore include the health sector, the finance industry, software engineering, life sciences and biotechnology. Economic research has emphasized the close inter-connectedness of innovation, local economic growth and cluster formation (Porter 2000; James 2005). *We define **knowledge clusters** as agglomerations of organisations that are largely production-oriented.* Their production is primarily directed to knowledge as output or input. Knowledge clusters have the organisational capability to drive innovations and create new industries. They are central places within a wider structure of knowledge production and dissemination (Evers, Gerke, Menkhoff 2010:648). Examples of organisations in knowledge clusters are universities and colleges, research institutions, think-tanks, government research agencies, and knowledge-intensive firms. What is important is the diversity of the players involved. They may complement one another, be in competition, or cooperate (Nick and Pinch 2006). Our research in Asian knowledge cities has demonstrated the relevance of these structures (Menkhoff et al. 2009; Menkhoff et al. 2010).

Knowledge hubs may exist in the same locations as knowledge clusters and may be nested within them. *We define **knowledge hubs** as local innovation systems, nodes in networks of knowledge production and knowledge sharing* (Evers, Gerke, Menkhoff 2010:649). They are characterised by high connectedness and high internal and external networking and knowledge sharing capabilities. As meeting points of communities of knowledge and

interest, knowledge hubs fulfill three major functions: to generate knowledge, to transfer knowledge to sites of application, and to transmit knowledge to other people through education and training. Knowledge hubs are always nodes in networks of knowledge dissemination and knowledge sharing within and beyond clusters (Chay et al. 2010; Evers et al. 2011).

Following the success of knowledge clusters and hubs elsewhere in Europe or the US, policy-makers in various developing countries have attempted to pursue strategies of creating robust and value-added knowledge systems qua innovative agglomerations of knowledge-intensive organizations, following the lead of Silicon Valley in the US or the Munich hi-tech belt. In the early 1980s, Indonesia declared four of its universities to be “centres of excellence”, and gave them particular financial support. The results were not convincing (Tjakraatmadja et al. 2011). Only isolated competence centres were established, and they were not adequately networked with other knowledge and production hubs. Knowledge clusters cum hubs were not created. Real human actors such as ‘connectors’, ‘brokers’ or ‘boundary spanners’ play an important role in positively influencing cluster dynamics and cluster culture (Zook 2004). Often, the management teams of newly created knowledge clusters (e.g. Malaysia’s Multimedia Supercorridor / MSC) do not fully utilize standard knowledge management tools such as communities of interest / practice which could help to overcome silo mentalities and to foster a knowledge culture prevalent in many successful knowledge clusters around the world characterized by both competition and collaboration (= cooptation) (Evers, Nordin, Nienkemper 2010). Against this background, an interesting research question is what lessons can be learned from the Singapore knowledge clustering case study?

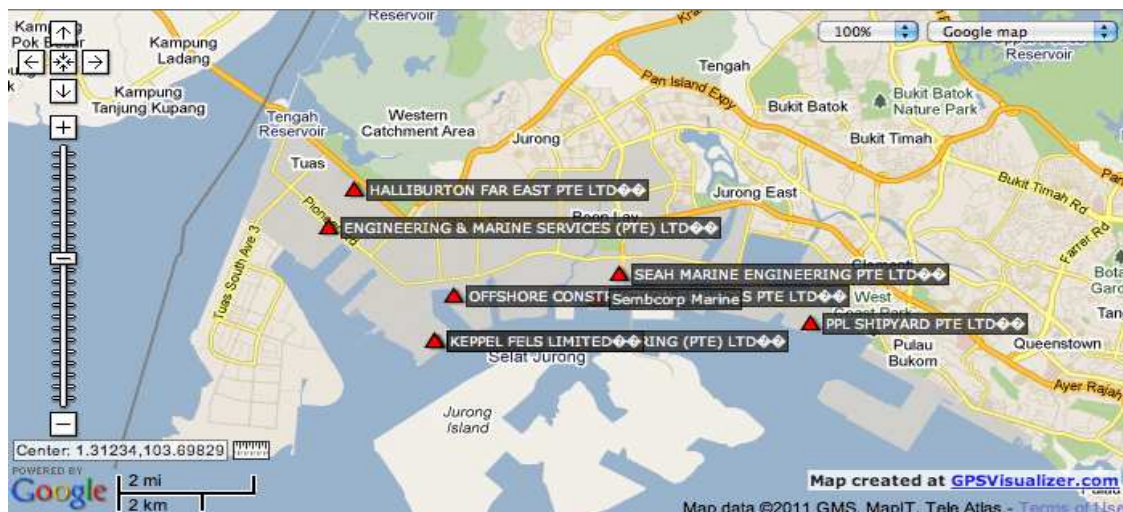
The knowledge governance approach of successful clusters has specific characteristics that can be made explicit. As a study of the wine industries in Italy and Chile has shown, firms with a strong knowledge base are more likely to exchange innovation-related knowledge with other firms. However, this is considered to occur only among firms whose cognitive distance is not too high. “This may explain the formation of densely connected cohesive subgroups and the emergence of local knowledge communities” (Giuliani 2007:163), or, in

our terminology, the formation of knowledge hubs. In the following, we will examine the governance specifics of two prominent knowledge clusters in Singapore and attempt to identify the various lifecycle stages (Sass et al. 2009; SRI international 2001) of these clusters. The cluster literature distinguishes between (i) the 'pre-cluster' or 'embryonic' stage where market actors co-locate but have not yet achieved institutionalized cooperation activities, the (ii) 'emerging' stage where actors start to cooperate qua agglomeration effect around a core activity, (iii) the 'collaborative' or 'established' stage where the cluster has gained a distinct identity and where the cluster has attracted new entrants due to real collaboration advantages and (iv) the 'mature' stage characterised by long-term sustainability and fully developed internal and external dynamics in form of new firm creation through start-ups, JVs, spin-offs etc. The final phase is the 'declining' stage where the cluster has peaked and is experiencing stagnation, inability to adapt to change and innovate etc. New technologies, new markets or new cluster entrants can avoid such a decline and help to transform the cluster into new cluster organizations so as to re-enter the lifecycle. Sustainable cluster management poses great challenges for both policy-makers and business leaders given the volatile business environment and competition dynamics in Asia. Singapore has considerable management capabilities in this respect as we shall see when we examine the origin, structure and evolution of the two clusters featured in this paper. We will also discuss some of the critical factors that shape and affect clusters such as important **cluster actors** such as firms or the research community, **spatial dynamics** (e.g. location), potentially synergetic **linkages and interrelationships** between and among cluster actors, related knowledge transfer mechanisms as well as **cluster performance**, for example in terms of new knowledge creation / innovation (Tallman et al. 2004; Meusburger 2000; Aziz 2011).

Case Study 1: The Singapore Marine Cluster (SMC)

Background and Location Specifics

Traditionally, shipping and port related sectors have formed the backbone of Singapore's economy due to the hub function of the city-state and its strategic location as an ideal place for the docking and repair of ships. Singapore's marine industry with its more than 5,000 maritime establishments represents more than 7.5% of Singapore's Gross Domestic Product (GDP) according to the Marine and Port Authority of Singapore (2010). The industry is divided into three main sectors: (i) Ship Repair and Conversion, (ii) Shipbuilding and (iii) Offshore. Together with maritime services such as shipping finance, marine insurance and maritime legal and arbitration services, they form part and parcel of the Singapore Marine Cluster (SMC). Since its creation in the 1960s, this cluster has played a significant role in Singapore's economy in terms of job creation and value added. In 2008, it provided 70,000 jobs of which 12,000 were skilled workers with an output in 2009 of S\$ 16.83 billion (Government of Singapore, 2010). The most important role, providing 55% of total industry earnings, is played by the offshore sector.



Map: Singapore's Maritime Cluster in Tuas

Respective cluster companies are situated in close proximity to each other in the south-western region of Singapore called Tuas (Association of Singapore Marine Industries, 2011) as illustrated on the map above. The Tuas marine cluster is close to the ports as well as other marine-related companies who supply several complementary services. With 70% of the global market share of Floating Production Storage Offloading (FPSO) vessel conversion, 70% of world market share for jack-up rig building and 20% of world market share for ship repair, Singapore's SMC boasts a comprehensive offering of repair services, conversions and new constructions for an international clientele. As a knowledge hub, the maritime cluster has successfully put Singapore on the world map due to both good knowledge governance at national level and effective knowledge cum talent management at the micro levels of both the hub and within participating firms. What makes the marine cluster tick?

Inside Singapore's Maritime Cluster: Key Governance Actors

Good knowledge governance by institutions such as Singapore's Economic Development Board (EDB), the Maritime and Port Authority (MPA), Agency of Science, Technology and Research (A*Star) etc. has played a key role in creating, maintaining and expanding Singapore's marine cluster. Besides business acumen, research and development (R&D), talent development etc., authorities managed to attract various shipping finance-related companies in order to expand the industry such as banks, boutique shipping investment banks, private equity arrangers, shipping finance advisers, shipping finance conference organizers and publishers of maritime finance transactional information etc. It also launched the first clearing facility for freight and energy derivatives in Asia, SGX AsiaClear (2006), to further strengthen Singapore's position as a key hub port for oil and maritime commerce to serve the Asian energy and Forward Freight Agreements (FFA) market. To nurture a culture of "maritime vibrancy and buzz", new flagship events were launched such as 'Maritime Week' or the maritime conference-cum-exhibition 'Sea Asia'. For the future it is planned, to further grow other maritime services such as shipping finance, marine insurance and maritime legal and arbitration services (http://www.maritimecareers.com.sg/maritime_industry_shipping_article2.html).

Inside SMC: The Keppel Offshore & Marine Hub

A key corporate actor within the SMC is the Keppel group of companies. Incorporated in 2002, Keppel Offshore & Marine has over 300 years of combined experience from the three companies under its wing, namely Keppel Fels, Keppel Shipyard and Keppel Singmarine. With its key competency of offshore engineering, **Keppel FELS** is the world's leader in offshore oil rig fabrication, globally renowned for its prowess at research and development (R&D). **Keppel Shipyard** specializes in marine engineering and has become a world leader in the conversion of Floating Production Storage and Offloading (FPSO), Floating Storage and Offloading (FSO) and Floating Storage and Re-gasification Units (FSRU). Specialized shipbuilder **Keppel Singmarine** complements both Keppel FELS and Keppel Shipyard because it provides the key supporting vehicles that would be required for ship conversion and oil rig fabrication. Keppel is well known for its competitive ability to deliver projects on time and within budget. In 2010, the Group completed 12 new built jackup and semisubmersible rigs, 5 major FPSP/FSRU conversion projects and 18 quality vessels worldwide safely, on time and within budget. As illustrated on the map below, Keppel Offshore & Marine's companies and yards are situated relatively close to each other within the SMC which facilitates knowledge sharing and creation, arguably key success factors in this business (Boschma 2005).

Altogether, Keppel employs over 30,000 employees in more than 30 countries following the motto "Near Market, Near Customer". In Singapore alone, the Keppel Group has a workforce of over 1,500 people. The workforce of Keppel Fels consists of 70% foreigners and 30% local talent. For every local person hired, a company in the marine sector is entitled hire three foreign work permit holders who are allowed to work for up to 15 years in Singapore. They are mainly recruited from China, India, Myanmar, Thailand, Bangladesh, Malaysia and Sri Lanka and work as welders, fitters, mechanics and other skilled laborers.



Map: Location of Keppel companies within Singapore's Marine Cluster in Tuas



Fabrication and Yard Facilities of Keppel in Tuas

In terms of product innovations, Keppel Offshore & Marine is well known for its innovative ultra deepwater solutions such as semisubmersibles, drilling tenders, or compact drill ships. It also managed to build the first pair of icebreakers in the hot Asian tropic region destined for customers in the West.

Keppel also has considerable operations management know how as evidenced by its ability to convert their former ship building yards into yards to build oil rigs due to the growing demand for deepwater drill rigs and diminishing demands for ships. This flexibility to adjust the shipyard's function to market demands in a highly volatile economy coupled with the ability to execute plans well forms part of Keppel's innovative DNA. It has also integrated its own steel factory into its supply chain to become less dependant on supply

constraints because steel is such an important component in their business which can also be sold profitably to other industries (Lim, 2011).

Strategic Knowledge Resources within the Keppel Hub

One of Keppel's most important knowledge resources is its **engineering know how** accumulated over 40 years of experience (Choo, 2010) as evidenced by the firm's ability to build / repair oil rigs and to carry out **completion projects** that could not be delivered on time by others (Keppel Offshore & Marine, 2010). Keppel's know how to drill for oil under harsh conditions gave them a head start in meeting the changing demands of the oil industry as cheap and easily accessible oil supplies are running out. This has also allowed the firm to take on **conversion projects** aimed at upgrading and converting older types of rigs into oil rigs capable of drilling in deep waters (Keppel Offshore & Marine, 2010).

Keppel differentiates itself by customized **designs** depending on location conditions which allows clients to maximize the amount of oil being drilled at each site. Its engineer designs take safety standards into consideration (Keppel Offshore & Marine, 2010) which helps to reduce human-prone errors that could result in disasters, enhancing clients' confidence in business continuity. Keppel has also patented their own rig designs (Keppel Offshore & Marine, 2010).



Through strategic **joint ventures with various supporting industries** etc. such as **Regency Steel Japan, Asian Lift Pte Ltd (Singapore) and Keppel Smit Towage Pte Ltd** and collaborations with research institutes and institutions of higher learning, Keppel has gained considerable knowledge in areas such as steel production, transportation of bulky mega products (rigs) safely across the sea through towage or construction of strong cranes to increase their lifting capacity (Keppel Offshore & Marine, 2010). This knowledge has enabled Keppel to remain independent without having to rely on external (and potentially unreliable) sources of raw materials and transportation services, thus allowing the group

to deliver to clients on time and on budget and to achieve considerable competitive advantages.

The firm's extensive knowledge and understanding of deep water conditions and future orientation has opened up a new market for building **offshore wind farms** (Keppel Offshore & Marine, 2010). The demand for wind farms as a source of alternative energy is predicted to increase in future and will make up 20% of energy production by the year 2030 (U.S. Department of Energy, 2008).

Knowledge Creation through Research & Development (R&D)

Keppel's innovation capability in designing oil rigs is based on four specialized R&D departments. The **Keppel Offshore & Marine Technology Centre (KOMtech)** spearheads the R&D of new technologies, processes and competencies. Its scope includes technology foresight into alternative energy applications as well as developing designs, systems and critical equipments for rigs and ships. The **Offshore Technology Development (OTD)** department is in charge of coming up with the foremost technology and techniques in the design of new generation jackup rigs and their critical systems. The **Deepwater Technology Group (DTG)** is in charge of in-house deepwater rig designs. The **Marine Technology Development (MTD)** specializes in the design and development of offshore support and maintenance vessels for a variety of operating conditions globally (Keppel Offshore & Marine, 2010).

Knowledge Transfer through Global Engineering Management Systems (GEMS)

Vertical and horizontal knowledge transfer is facilitated by Keppel's IT-enabled, so-called **Global Engineering Management System (GEMS)**, a central information and knowledge repository which also provides R&D support. This powerful tool, also known as the Global Engineering Hub (Keppel Offshore & Marine, 2010), allows Keppel Offshore & Marine engineers to work on a **common web-based platform** across geographic boundaries, without compromising security. GEMS is accessible worldwide and helps Keppel employees to constantly share and gain knowledge regardless of where they are stationed. (Keppel Corporation, 2006).

Collaboration with Research and Educational Institutions

Keppel maintains vast linkages to various external stakeholders which helps the organization to create new knowledge and to innovate such as research and education institutes or joint ventures with related corporations. Collaboration partners include **A*Star, Singapore Polytechnic (SP), Ngee Ann Polytechnic (NP), National University of Singapore (NUS) and Nanyang Technological University (NTU)**. Key elements include an offshore engineering program for talented students (Choo, 2010) and the establishment of the **Centre for Offshore Research & Engineering (CORE)** in the Faculty of Engineering at NUS (2003) spurred by the endowment of the Keppel Professorship in Ocean, Offshore and Marine Technology. The latter was launched in 2002 with a gift from Keppel Corporation Limited. Examples of joint Keppel-CORE projects are ‘Improved Guidelines for the Prediction of Geotechnical Performance of Spudcan Foundations during Installation and Removal of Jack-up Units (InSafeJIP)’ and the ‘Spudcan-pile Interaction Joint Industry Project’.

Challenges Ahead

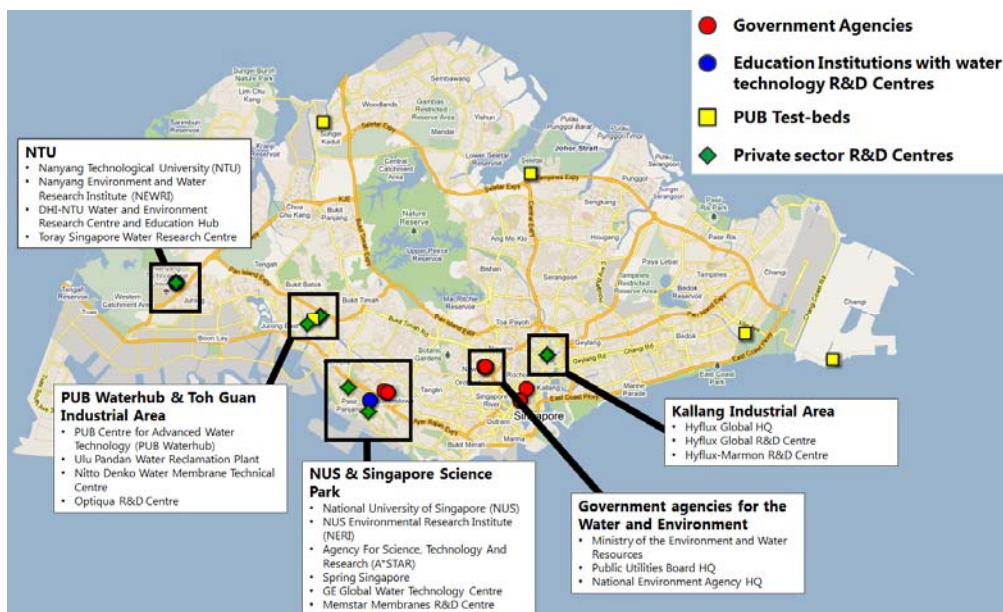
The strongest challenges facing Keppel’s oil rig hub are likely to be environmental concerns related to oil drilling activities. Governments, corporations and communities at large have expressed concerns on the impact of offshore activities on the environment following a series of oil spills and environmental breaches on strict regulations from offshore activities. These events have put pressure on Keppel and its competitors to frame their businesses to be more environmentally friendly.

Case Study 2: Singapore’s Water Hub

Background and Location Specifics of Singapore’s Water Hub

On 2 October 1961, an agreement was signed between the city council of the state of Singapore and the government of Johor. The Tebrau and Scudai Rivers Water Agreement and the Johor River Water Agreement, made a year later, enabled one the most water-scarce countries in the world (Singapore) to embark on an epic modernisation programme.

Although the agreements defined the terms and prices of water supply, they have been a source of friction between the two nations in recent years with Malaysia seeking to revise the water price upwards and Singapore insisting on adhering to the agreements. With Malaysian politicians frequently calling for the tap to be turned off, Singapore decided in 2002 that the 1961 Water Agreement will not be renewed after it expires in 2011, and that it would begin to look at developing alternative sources of water.



Map: Locations of Key Players in Singapore’s Environment and Water Industry

The establishment of a diversified water supply (coined the Four National Taps), implementation of holistic water management practices, and the promotion of a water conservation culture are significant achievements that Singapore has made in recent years as it progresses towards self-sufficiency in terms of water supply by 2061.

Singapore’s water research and activity hubs are primarily located in the southern shore regions. While some test beds, research centres and collaborating educational institutions are geographically close to each other, the entire cluster is still evolving due to its relatively young age and the recency of water-related policy issues and forceful interventions which were instrumental for its rapid evolution.

Internal Knowledge Processes

Linkages between the actors in the water industry

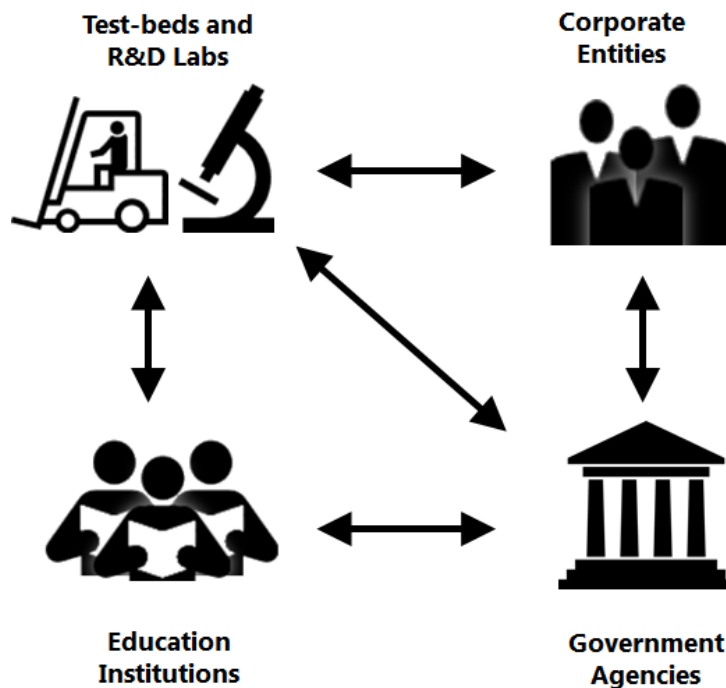


Figure: Linkages between the actors in the water industry

A key governance role is played by the so-called Environment and Water Industry Programme Office (EWI), formed in conjunction with a 2006 declaration by the Singapore Government to turn the environment & water industry into a strategic growth area with a \$330 million commitment over 5 years aimed at developing Singapore into a global 'hydrohub'.

The government's engagement with corporate entities is seen not just through its efforts in attracting large international players to anchor their R&D, engineering, manufacturing and headquarter activities in Singapore, but also in grooming local companies to be key players in the regional and global water markets. It also tries to provide a conducive environment

for start-up companies in the industry through the creation of the **Singapore Water Association** which acts as a forum for the exchange of ideas and knowledge etc.

Education institutions also play a key role in the emerging water cluster. There is ample government support in form of subsidies for Masters and PhD programmes as well as scholarships aimed at creating more knowledge workers and sending students overseas to top institutions with reputable water technology research programmes. An important local node is the Institute of Water Policy¹ at the Lee Kuan Yew School of Public Policy which was created to develop better water governance policies.

With the help from EWI, several corporate entities have chosen to collaborate with research centres in local education institutions such as the Nanyang Environment & Water Research Institute (NEWRI) at the Nanyang Technological University (NTU) or the NUS Environmental Research Institute (NERI) at the National University of Singapore (NUS). There are considerable test-bedding opportunities in Singapore in form of PUB-related facilities² like waterworks, NEWater factories and reservoirs. The EWI has special schemes³ to accelerate the commercialisation of new environment and water technologies through their early adoption in Singapore - providing developers with a platform to test their products in real-life operating conditions, and helping them build a track record for their technologies to facilitate market entry.

Other key initiatives of EWI's strategy to build up the environment and water technology industry in the context of cluster development include getting major international water companies to anchor their R&D, engineering, manufacturing and HQ operations in Singapore; grooming local companies to be players in the regional and global water markets; and creating a conducive environment for start-up companies in the industry. Capability development (e.g. through specialized manpower development programmes)

¹ Institute of Water Policy <http://www.spp.nus.edu.sg/iwp/Home.html>

² Singapore as a Global Test Bed <http://www.pub.gov.sg/ewi/CapabilityDev/Pages/GlobalTestBed.aspx>

³ TechPioneer Scheme by the EWI <http://app.mewr.gov.sg/data/ImgCont/985/TechPioneerBrochure020908.pdf>

represents another key policy goal to promote Singapore as a Global Hydrohub. Another (networking) vehicle is the new **Singapore Water Week** which took place in July 2011.

Key Government Actors in Singapore's Water Hub

Key governance agencies within the Environment and Water Industry Programme Office (EWI) include the Ministry of the Environment and Water Resources (MEWR), the Public Utilities Board (PUB), the Agency for Science, Technology and Research (A*STAR) and EDB.

Ministry of the Environment and Water Resources (MEWR)⁴

MEWR began as the Ministry of Environment in 1972 but changed its name in 2004 to reflect its expanding role in managing water as a strategic national resource. The EWI comes under the MEWR with the aim of boosting the development of the local environment and water industry through R&D and educational programmes.

Public Utilities Board (PUB)⁵

Known as the national water agency, the PUB played a big part in helping Singapore overcome water shortages despite its lack of natural resources and pollution in its rivers. Beyond its strategic role in managing the country's water supply, water catchment and used water in an integrated way, PUB is now moving towards using water as a means to beautify Singapore's landscape and improve Singaporeans' quality of life to realise the vision of Singapore as a City of Gardens and Water

Agency for Science, Technology and Research (A*STAR)⁶

Formerly known as the National Science and Technology Board, A*STAR was established in 1991 with the primary mission to raise the level of science and technology in Singapore.

⁴ Ministry of the Environment and Water Resources <http://app.mewr.gov.sg/>

⁵ Public Utilities Board <http://www.pub.gov.sg>

⁶ Agency for Science, Technology and Research <http://www.a-star.edu.sg>

A*STAR supports Singapore's key economic clusters by providing the intellectual, human and industrial capital to its partners in industry.

Economic Development Board (EDB)⁷

Together with the PUB, EDB plays a key leadership role in the EWI with the aim of attracting more companies to locate their operations in Singapore. It also helps grow local environmental companies, encourage more companies and research institutes to develop cutting-edge environment and water technology and then help export Singapore's capabilities to growing markets around the globe.

Key Corporate Actors

Some of the significant corporate players in Singapore's increasingly thriving water industry are Hyflux, (government-linked) Keppel Corporation, GE Water & Process Technologies (GE Water), Siemens Water Technologies and others.

Achievements⁸

Today, Singapore is increasingly recognised as a global hydrohub with more than 70 local and international organisations in its vibrant water and environment ecosystem ranging from R&D, engineering, manufacturing to headquarters activities. A significant indicator of success is the fact that Singapore-based companies have secured overseas contracts worth S\$8.4bn since 2006. The economic impact from investments by water companies from 2006 – 2010 include 2,300 new professional & skilled jobs and S\$590 million of annual value-added to the economy.

⁷ Economic Development Board http://www.sedb.com/edb/sg/en_uk/index.html

⁸ Briefing by the EWI 26 May 2011

http://www.sedb.com/etc/medialib/downloads/pdf_documents_for0.Par.4763.File.tmp/Presentation%20for%20Media%20Briefing%20on%20Water%20Industry.pdf



Fig: Significant Projects in Middle East North Africa Region



Fig.: Significant Projects in Asia Pacific Region

Due to successful cluster governance and industry participation, Singapore has developed strong capabilities in water management, new water technologies such as membrane applications and large-scale water reclamation with international projects in Australia, China and the Middle East. These achievements were recognized through the 2007 Stockholm Industry Water Award to Singapore.

Conclusion

In this paper we compared two distinct knowledge clusters in Singapore, the oil rig business cluster centering on Keppel Corporation and the republic's increasingly dynamic hydrohub (WaterHub). Both contribute significantly to Singapore's development, albeit operate at different stages in the cluster lifecycle.

Keppel is ahead in the global oil rig fabrication business due to its ability to generate and share new knowledge effectively both within its own cluster of companies and across significant stakeholders in business and society. Due to strong knowledge leadership, Keppel is able to harness and manage knowledge through strategic R&D and sound management in various areas such as talent management, operations management, innovation management or sales and marketing. As of 2007, Singapore held twenty-three patents for oil rig construction with nine out of eleven patents awarded to Singaporean companies between the years 2000 to 2007 (Wong, Ho, & Singh, 2007). While the number of researchers within the marine engineering industry (which the offshore sector is classified under) is still relatively low compared to other scientific fields, it is steadily increasing due to the higher importance of R&D for competitive advantage and the need to come up with new (greener) business models. Keppel has identified key areas for future expansion to fight off threats from other companies and to meet future needs, e.g. with regard to alternative energy sources. The marine cluster appears to be very robust. Over time, the flourishing rig business has encouraged the growth of supporting firms in the local marine services sector such as logistics and procurement support services, chartering of offshore supply vessels, rig repair services or IT services for mutual advantage. Our analysis suggests that the rig cluster is currently in its *'mature' stage* characterised by

strong internal and external dynamics in form of new firm creation through start-ups, JVs, spin-offs etc. As such, through constant knowledge innovation and adaptation to environmental concerns, Singapore's oil rig business cluster will continue to be the world's leader in the fabrication of oil rigs and exploration of alternative energy thus contributing to Singapore's economic longevity. Due to the successful search for new technologies and markets, the cluster will eventually successfully enter the 'transformation' stage with new cluster constellations and avoid the 'declining' stage.

Based on our analysis so far, we conclude that Singapore's waterhub cluster is geographically subdivided into several smaller clusters. Within these clusters, we find several 'hubs', often in form of specialised buildings (vertical localities) where key corporate players are located close to each other with easy access to both public and private sector research centres in form of NEWRI, Waterhub & NERI. Given Singapore's small geographical area and good transportation infrastructure that connects R&D centres with test-beds and manufacturing facilities, companies are able to enjoy a decent level of both horizontal and vertical clustering. Stage-wise, we position the waterhub **between the 'emerging' stage where actors start to cooperate qua agglomeration effect around a core activity (e.g. membrane R&D) and the 'collaborative' or 'established' stage** where the cluster is gaining a distinct identity, attracting new entrants due to value-added collaboration advantages. Given very strong local needs to expand new water supplies and catchment areas as well as competent political steering and governance, there is no doubt that Singapore's water cluster will (sooner than later) reach the 'mature' stage characterised by long-term sustainability and fully developed internal and external dynamics in form of new cluster organizations. Collaboration between citizens, government and industry will be crucial for a sustainable water future in Singapore and beyond.

Some key lessons latecomers in the knowledge race can derive from the Singapore case are as follows: (i) leverage on your location advantage if you have one; (ii) build a solid skills-based foundation before you think global and align the local education system with the demands of a knowledge-based economy and (iii) get industry excited about future cluster

prospects, e.g. in the context of PPP frameworks and with the help of good knowledge governance and strategic R&D. 'Uniquely Singapore' (and difficult to replicate) is arguably the very strong local need to become independent from Malaysian water supplies which motivated the government to take charge in developing a (global) hydrohub and also the legacy of British colonialism in form of a seizable infrastructure of shipyards and marine technology know how upon which the current marine cluster and Keppel's success story are (historically seen) based.

References

Boschma, Ron. 2005. "Role of Proximity in Interaction and Performance: Conceptual and Empirical Challenges." *Regional Studies* 39:41-45.

Business Times July 6, 2011. "Towards a 50-year plan for water sustainability (by Heiner Markhoff).

Carrillo, Francisco J. 2004. "Capital cities: a taxonomy of capital accounts for knowledge cities." *Journal of Knowledge Management* 8:28-46.

Carrillo, Francisco Javier. 2006. *Knowledge Cities: Approaches, Experiences and Perspectives*: Butterworth-Heinemann.

Chay, Yue Wah, Thomas Menkhoff, Benjamin Loh, and Hans-Dieter Evers. 2010. "What makes Knowledge Sharing in Organisations Tick? An Empirical Study." Pp. 301-325 in *Governing and Managing Knowledge in Asia*, edited by Thomas Menkhoff, Hans-Dieter Evers, and Yue Wah Chay. Singapore: World Scientific.

Evers, Hans-Dieter, and Azhari Karim. 2011. "The Maritime Potential of ASEAN Economies." *Journal of Current Southeast Asian Affairs* 30(1):117-24.

Evers, Hans-Dieter. 2011. "Knowledge Cluster Formation as a Science Policy: Lessons Learned." Paper read at the *Science, Technology and Society Workshop, 23-24 September 2011* Bandar Seri Begawan: Universiti of Brunei Darussalam.

Evers, Hans-Dieter, Solvay Gerke and Thomas Menkhoff. 2011. "Knowledge Hubs and Knowledge Clusters: A Knowledge Architecture for Development", Thomas Menkhoff, Hans-Dieter Evers, Chay Yue Wah and Pang Eng Fong (eds), *Beyond the Knowledge Trap – Developing Asia's Knowledge-based Economies*. World Scientific, pp. 27-45.

Evers, Hans-Dieter, Solvay Gerke, and Thomas Menkhoff. 2010. "Knowledge Clusters and Knowledge Hubs: Designing Epistemic Landscapes for Development." *Journal of Knowledge Management* 14(5):678 - 89.

Giuliani, Elisa. 2007. "The selective nature of knowledge networks in clusters: evidence from the wine industry." *Journal of Economic Geography* 7:139-168.

Henry, Nick, and Steven Pinch. 2006. "Knowledge and Clusters." Pp. 114-132 in *Clusters and Globalisation*, edited by Christos Pitelis, Roger Sugden, and James R. Wilson. Cheltenham: Edgar Elgar.

Hornidge, Anna-Katharina. 2007. *Knowledge Society: Vision and Social Construction of Reality in Germany and Singapore* Berlin and London: LIT Verlag.

Hornidge, Anna-Katharina. 2006. "Singapore: The Knowledge-Hub in the Straits of Malacca." in *ZEF Working Papers Nr. 14*. Bonn: Center for Development Research, University of Bonn.

Iammarino, S., and P. McCann. 2006. "The structure and evolution of industrial clusters: Transactions, technology and knowledge spillovers." *Research Policy* 35:1018-1036.

James, A. 2005. "Demystifying the role of culture in innovative regional economies." *Regional Studies* 39:1197-1216.

Kamarulzaman AB Aziz 2011. "The Dynamics for Sustainable Cluster Development: A Comparative Study of the Multimedia Super Corridor and the Glasgow - Edinburgh Corridor." Unpublished PhD Study, Multimedia University. Malaysia.

Menkhoff, Thomas, Solvay Gerke, Hans-Dieter Evers, and Yue Wah Chay. 2009. "Wissen und Entwicklung in Singapur." *ASIEN - The German Journal on Contemporary Asia*, No. 112 (July), pp. 31-51.

Menkhoff, Thomas, Hans-Dieter Evers, and Yue Wah Chay (Eds.). 2010. *Governing and Managing Knowledge in Asia, 2nd revised edition*. New Jersey, Singapore and London: World Scientific Publishing.

Menkhoff, Thomas, Evers, Hans-Dieter, Chay Yue Wah and Pang Eng Fong (eds). *Beyond the Knowledge Trap: Developing Asia's Knowledge-based Economies*, New Jersey: World Scientific Publishing 2011.

Menkhoff, Thomas, Evers, Hans-Dieter, Chay Yue Wah and Solvay Gerke "Achieving Knowledge Economy Status through Good Knowledge Governance: The Singapore KBE Story Revisited", Thomas Menkhoff, Hans-Dieter Evers, Chay Yue Wah and Pang Eng Fong (eds), *Beyond the Knowledge Trap - Developing Asia's Knowledge-based Economies*. World Scientific, 2011, pp. 299-323.

Meusburger, Peter. 2000. "The spatial concentration of knowledge. Some theoretical considerations." *Erdkunde* 54:352-364.

Munnich, Lee W. Jr., Greg Schrock, and Karen Cook. 2002. "Rural Knowledge Clusters: The Challenge of Rural Economic Prosperity." *Reviews of Economic Development Literature and Practice, University of Minnesota* 12.

Pinch, Steven, Nick Henry, Mark Jenkins, and Stephen Tallman. 2003. "From 'industrial districts' to 'knowledge clusters': a model of knowledge dissemination and competitive advantage in industrial agglomerations." *Journal of Economic Geography* 3:373-388.

Porter, Michael. 2000. "Location, Competition, and Economic Development: Local Clusters in a Global Economy." *Economic Development Quarterly* 14:15-34.

Sass, M., Szanyi, M., Csizmadia, P., Illessy, M., Iwasaki, I. and Mako, C. 2009. "Clusters and the Development of Supplier Networks for Transnational Companies". Working Paper 187. Institute of World Economics, Hungarian Academy of Sciences, Budapest.

SRI International 2001. "The Illinois Model of Technology Driven Economic Development." http://www.illinoisbiz/tech/pdf/cluster_overview.doc

Tallman, Stephen, Mark Jenkins, Nick Henry, and Steven Pinch. 2004. "Knowledge Clusters and Competitive Advantage." *Academy of Management Review* 29:258-71.

Tjakraatmadja, Jann Hidajat, Wicaksono, Agung and Lenny Martini. 2011 "Knowledge Sharing in Indonesian Context: Institut Teknologi Bandung (ITB) as Potential Knowledge Hub To Create Value from Academia, Business and Government Linkages", in: Thomas Menkhoff, Hans-Dieter Evers, Chay Yue Wah and Pang Eng Fong eds. "Beyond the Knowledge Trap: Developing Asia's Knowledge-based Economies", New Jersey: World Scientific Publishing 2011.

Weber, Alfred 1909. *Über den Standort der Industrien. Erster Teil: Reine Theorie des Standorts*. Tübingen: Verlag JCB Mohr.

Wong, Poh-Kam & Ho, Yuen-Ping & Singh, Annette 2007. "Towards an "Entrepreneurial University" Model to Support Knowledge-Based Economic Development: The Case of the National University of Singapore." *World Development* 35(6): 941-958.

Zook, Matthew. A. . 2004. "The knowledge brokers: venture capitalists, tacit knowledge and regional development." *International Journal of Urban and Regional Research* 28:621 - 641.