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## **COMMERCIAL PRESSURE, LOCAL RESPONSIVENESS AND SYNERGIES IN GLOBALISED ENGINEERING SERVICES**

CHRISTIAN KOCH

Chalmers University of Technology, Civil and Environmental Engineering, Sweden  
kochch@chalmers.se

DAVID BENNETT

Chalmers University of Technology, Technology Management and Economics, Sweden  
Aston University, Business School, UK  
University of South Australia Business School, Australia  
david.bennett@chalmers.se (Corresponding)

### **ABSTRACT**

This paper investigates how medium-size engineering service companies working traditionally in national markets have engaged with challenges of globalisation and competition from multinationals. The Nordic region has many smaller domestic engineering services companies in the industry, which are under pressure in their established national and wider international markets. The research uses mixed-methods with empirical data from a desk study of sector development supplemented by qualitative studies of individual companies. It also includes comparative case study analyses of two medium-size engineering service companies with headquarters in two different Scandinavian countries. Among the companies studied there is a plethora of strategies and diversification into other revenue generating activities. Mergers and acquisitions are the most important strategies among the largest companies. Also there are a number of network strategies involving local resources from sister companies etc. The case companies illustrate many of the findings. They both have a multidisciplinary profile in the Nordic region while establishing a more limited presence in North America and elsewhere in Northern Europe. They are also developing a global business focusing on separate areas such as large bridges, environmental consulting, developmental consulting and industrial engineering. The research reveals an array of different strategic positions that combine local, regional and global elements resulting in unique strategic “bundles”. The paper adds to strategic technology management concepts and approaches by identifying the strong role of emergent strategy moves made by senior managers in the companies. It complements established theory and practice concerning the Resource-Based View and Knowledge-Based View as well as on network operations and extended enterprises.

**Key words:** engineering services; competitive strategy; Nordic countries; international collaboration; strategic technology management

### **INTRODUCTION**

The North American Industry Classification System defines the “engineering services” industry as comprising establishments primarily engaged in applying principles of engineering in the design, development and utilization of machines, materials, instruments, structures, processes and systems. The assignments undertaken by these establishments may involve any of the following activities; the

provision of advice, the preparation of feasibility studies, the preparation of preliminary and final plans and designs, the provision of technical services during the construction or installation phase, the inspection and evaluation of engineering projects, and related services (NAICS, 2012). Engineering services firms are working increasingly within a multinational business environment. The very largest have become global players by extending their reach beyond traditional domestic and regional markets, often through mergers and acquisitions. However, a second group of medium-size engineering services firms on the other hand have extended their international reach through the use of external resources (outsourcing), by relocating internal activities (the captive arrangement of foreign direct investment), or through cooperative ventures with partners. In countries like China and India cooperation with local firms gives access to highly qualified engineers at a relative low level of remuneration compared with expatriate counterparts from Western countries.

### **Paper background, aim**

This paper considers how the second group of medium-size engineering service companies, which have worked traditionally in domestic national markets, are engaging with the challenges of globalisation and competition from the larger multinational companies that use their size and reach to become dominant players in world markets. Its focus is on the Nordic region (The Scandinavian countries of Sweden, Denmark and Norway together with Finland), where there are many smaller domestic engineering services companies in the industry, which are under pressure in their established national and wider international markets. For various historical reasons the Nordic region has many such smaller domestic companies in the industry, but they are subject to increased competition in both their established national and wider international markets. The paper's purpose is to investigate how these Nordic medium-size engineering service companies, coming from a tradition of working in national markets, have applied the concepts of strategic technology management and other business strategy approaches in response to the challenges faced by industry globalisation. The investigation is predicated on the proposition that strategies for extending the enterprise such as outsourcing, strategic partnerships, joint venturing and technology/knowledge transfer can enable them to compete on a more equal footing with the larger players.

### **Sector – background**

In 2016 the revenue of global engineering services companies globally was reported to be USD 773 billion with annual growth since 2011 of 3.3%. The industry comprised 747,000 businesses employing 4,081,000 people (IBIS World, 2016). The size of companies in the sector ranges from very small firms with just a handful of people to those with over 50,000 people employed. The largest currently has more than 90,000 employees. Compared with engineering companies involved directly with manufacturing they generally have a low level of capital intensity and high labour intensity. They operate in a range of infrastructure and utilities sectors including transportation, energy and power, building and road construction, as well as projects for the industrial and manufacturing sectors. They engage in a wide range of activities including design and management services for construction and infrastructure projects, environmental projects and industrial automation. Their portfolio includes construction management, process management (e.g. assessing engineering and product problems), project planning, project management and economic assessments. Relative to those in many other Western countries the engineering services companies in the Nordic countries

are comparatively small. For example Table 1 shows that only one percent of Swedish companies in the sector have more than 100 employees (STD, 2016).

*Table 1: Size distribution of Swedish engineering services companies*

<b>Number of Employees</b>	<b>Number of Companies</b>
501-	16
101-500	47
51-100	49
21-50	156
11-20	200
3-10	960
0-2	9,700
Total	11,128

## LITERATURE CONTEXT

Several strands of literature are pertinent to this research. They come from the general disciplinary areas of Business Strategy, Management of Technology, International Business, and Services Outsourcing.

Within Business Strategy the principal literature relevant to this work is concerned with the resource-based and knowledge-based views (Barney, 1991), which advocate building core competencies within the firm as being an effective basis for achieving success in a fast-changing competitive environment. The Business Strategy literature also deals with trade-offs between global integration/synergy and local responsiveness, which recognises that with a more fragmented global marketplace, distinct local customer needs, local sourcing imperatives, heterogeneous costs, and trade barriers, the less the degree of globalisation and therefore the greater the imperative for localisation (Brock and Siscovick, 2007; De Wit and Meyer 2014).

In Management of Technology, the subjects of technology strategy and technology partnerships are most germane to the research. Betz (1998) establishes a coherent argument for taking a strategic management view of technology by linking economic goals, core competencies, managing innovation in product development within the project management context, technology planning, invention, implementation of technology in products and services and manufacturing, organizational structure, technology substitution, forecasting of the rates and directions of technological change and possible discontinuities, together with research strategy and planning.

The International Business literature that is of interest to engineering service firms relates to the area of international partnerships, mergers and acquisitions (M&As). For example, Hagedoorn and Guysters (2002) investigate under which conditions companies prefer strategic technology alliances, M&As, or a combination of these, as alternative external sources of innovative capabilities. In their research they find greater endogenous innovative capabilities in M&As of engineering services firms than in other types of service business. Blessmann and Savelberg (2012) also investigate the role of M&As in consolidating the engineering sector.

Finally, Services Outsourcing (or offshoring when done internationally) emerges from the literature as one of the principal means whereby engineering services firms are seeking to be globally competitive while retaining the flexibility associated with companies in the medium-size group that is the focus of this study (Koch and Bennett, 2013). In their study of outsourcing over more than 30 years Hätönen and Eriksson (2009) observe that it has changed from being strictly cost focused during the 1980s towards now having a more cooperative nature. Therefore cost has become only one, often secondary, decision-making criterion. So, as a corporate strategy, outsourcing has evolved from the transactional approach to a more developmental form in which the outsourced process is co-developed with the outsourcing provider. McIvor (2010) identifies services outsourcing as being either task-oriented or business-process-oriented. Engineering services use both types in their design, management and technical support activities. McIvor also sees standardisation as a means of facilitating outsourcing to specialist vendors, but this is less feasible for the more bespoke business environment within which most engineering services firm operate. Messner (2008) considers international outsourcing of engineering services in the construction industry and concludes that it will clearly have an impact, but may not mirror the trends in other service or manufacturing industries. Messer argues that most offshore outsourcing has been done for large capital facility projects that require many engineering hours, with such projects being undertaken only by the larger engineering companies in high-income markets throughout the world. He also suggests that some engineering companies have focused on systemising the work of global virtual teams to benefit from offshore engineers, although many have not revised their standard business practices to use lower cost engineers for providing services. This is because of the concern that using lower cost engineers will have a negative impact on the quality of engineering services, thereby decreasing, or even negating, any benefits from reducing engineering labour costs. This even causes some to argue for “nearshoring” or “reshoring”, which results from a conscious decision to move previously offshored value creation activities back to domestic locations or to reintegrate outsourced value creation activities back into the organisation (Bals et al, 2016; Bäumer et al, 2012).

## **METHOD**

Based on the issues and questions identified from the literature this paper investigates the national markets and players in engineering services in the four main Nordic countries of Denmark, Sweden, Norway and Finland. The research is based on a mixed-methods approach with empirical data derived from desk study of how the sector has developed, supplemented by qualitative studies of individual companies. The desk study has reviewed the ten largest engineering services companies in the world and made comparisons with the major companies in the Nordic region. This aspect was part of an ongoing longitudinal study of small and medium-size engineering service companies in Denmark (small = 0-1,000 employees; medium = 1,000-20,000 employees). The research was undertaken within a theoretical framework comprising five elements, i.e. competency theory; leadership and teamwork; general knowledge areas; international expansion; and cultural issues. The paper provides two case studies of medium-size engineering service companies with headquarters in different Scandinavian counties. One has an 87 year history and approximately 6,500 employees. The other has a 37 year history and around 3,000 employees. Empirical data for the case studies were gathered from externally published materials and internal company documents together with information collected through the semi-structured interviews.

### **Case 1 Engserv A**

This company has a well-established multidisciplinary profile (STD 2002-2016), yet at a time profiled itself globally on specialist civil engineering design services. Its strategic profile is thus a mixed one. Through organic growth and acquisitions it has around 100 branch offices worldwide and tripled its number of employees over the last 20 years. Half of the offices are in Denmark, Norway and Sweden

with the remainder focused on North America and a few key markets in the emerging economies within Europe, Africa and Asia. The concentration of offices mirrors where the multidisciplinary profile is in operation. The Nordic presence of the company is extensive and supports a strategy of providing multidisciplinary professional services in locally responsive manner. Disciplines includes industry engineering, IT, energy, environment, management, civil engineering and building design.

Projects emanating in this area might be partly solved in the company's international offices, for example using Eastern European, Indian or Chinese located employees or external partners. Thus its competitive strategy involves using competitively priced engineering services beyond Western Europe. This integration occurred over the last ten years. It was initiated in an emergent manner and was for long very dependent on business unit managers and senior project managers accepting this element into their projects at a local business area level of their operations. The strategy was further enabled by a more permanent and stabilised local organisation in one Eastern European country and also in India, streamlining the processes of distributing project execution. Also an extensive IT infrastructure include technical CAD systems, and ERP was put in place to support this.

Both locally and in its international civil engineering activities it is a recurring observation that Engserv A teams up with other providers using temporary employees borrowed from other engineering services companies and outside agencies etc. Such employees are sometimes called "hired guns" (Barley and Kunda, 2004) and have become an essential part of the knowledge economy. They provide numerical and functional flexibility for firms that lack sufficient permanent resources to undertake every part of a project.

## **Case 2 Engserv B**

Engserv B is an engineering consultancy company predominantly working in industrial engineering (STD 2016). It has doubled its number of employees over the last 15 years to nearly 3000. Since 2000 the company has undergone a continuous international expansion. More than 40 offices are now established, with half of them located in the Scandinavian countries. Its presence elsewhere includes Europe and the BRIC countries (Brazil, Russia, India, China). The expansion reflects a strategy whereby Engserv B follows some of its large customers, for example in the automotive industry, which prefer using just one or a few consultancy partners, no matter where they operate.

Engserv B has also acquired a series of companies in the Nordic market. To integrate these new acquisitions, distributed business management and organisational processes have been used, focusing on project management competences, standardisation, and human resource management (HRM). Another element of the company's strategy is to use competitively priced engineering services in Eastern Europe, India and China.

Despite its growth and more international configuration, Engserv B is still too small compared with most competitors to be stable, and is therefore seen as a company that might be acquired by a larger player in the future. Consequently Engserv B has its own strategy to grow larger through further acquisitions. Management has developed and fine-tuned a procedure and a team organisation for the acquisition processes to enable a smooth transfer of new organisational elements into the overall business organisation. This includes a systematic search for, and organising of, engineering competence synergies at a time when continued presence and local branding is a

priority. Five major acquisitions over the last ten years have been integral to the international expansion alongside establishment of new offices in four countries.

## **COMPARATIVE ANALYSIS**

The five largest providers of engineering services in terms of people employed are all based in North America USA and Canada. They are AECOM (with headquarters in Los Angeles, California, employing 95,000 people), Bechtel Group Inc, (also with headquarters in San Francisco, California, employing 53,000 people), Fluor Corp. (with headquarters in Irving, Texas, employing 44,000 people) and SNC-Lavalin Group Inc. (with headquarters in Montreal, Canada, employing 39,000 people). Behind this group of the very largest companies there are a number of others (with between 15,000 and 30,000 employees). These are based in the Netherlands, France, Germany Japan, Australia, the UK and China (where a large company was created in 2002 by the State Power Corporation) as well as North America. (Technavio, 2014). Within the Nordic countries the largest engineering services firm in terms of people employed is based in Sweden (Sweco with just under 15,000 employees after a recent acquisition). Among the 55 companies in Europe with more than 2,000 employees, three are Swedish, two are Danish, two Norwegian and one Finnish (STD, 2016).

There is consequently a lack of concentration in the Scandinavian area that does not correspond to the critical mass among engineering services globally. However, a series of dynamics are pushing for further concentration. The synergies of the European single market include common standards for engineering design, materials, fiscal issues, tendering and contracts. Moreover the global concentration includes both supplier industries (materials and IT) as well as customer industries. These dynamics are pushing for mergers and acquisitions in the Scandinavian market, which also are underlined by the relative economic and industrial strength of Scandinavian economies. However counter dynamics also exists from the parts of the industry in Scandinavia consisting of medium-size companies that prefer using locally present engineering consultants, and even "in-house" consultants used regularly over international professionals. There is also a tendency of maintaining local markets in and around cities where clustering occur. Finally, in Scandinavia the public sector is often a major client for engineering services and frequently has a local bias when choosing suppliers.

## **DISCUSSION**

Both companies have used extensive collaboration with universities and large clients as a main element for continually developing competences of new technologies and finding how to manage them strategically. Moreover adoption of various knowledge management practices are also common. Engserv A have also prioritised the development of internal IT competences and operational units, where the company's own IT architecture can even serve as a testbed for external services offered. On the other hand Engserv B has been more focused on managerial and organizational approaches to managing new technological development.

Where the company perform overall business strategies, these also tend to be supplemented by more project by project oriented practices where a number of ad hoc alliances, local collaboration, sourcing of competencies, mutual lending out of employees, joint projects etc. means that the total strategy becomes bundled of a number of elements.

The analysis shows how both companies have active strategic approaches towards mergers and acquisitions and demonstrates that they realise growth in key existing markets as well as from new emerging markets. Nevertheless the issue here is whether their expansion is occurring fast enough to consolidate their position as independent companies or whether it is more likely that they will be the object of acquisition by much larger engineering companies, which have more comprehensive capabilities when it comes to operating globally and exploiting the emerging engineering “pools” in China and India, which are providing engineers at a lower cost and enabling global engineering services to create competitiveness with almost disruptive character (i.e. offering large scale high value engineering in Scandinavia at 25% lower price).

The analysis also shows that the engineering service market has become a disruptive area dominated by a few large global players compared with the past where companies have operated in protected local markets. It reveals an array of strategies combining local, regional and global elements resulting in unique strategic “bundles”. As with many other industries in the service and manufacturing sectors there has been a tendency towards outsourcing of engineering services with currently the largest destination being India, which accounts for 25 percent of outsourced engineering (NASSCOM, 2006). China is also an important location with its role expected to increase in coming years, while several other newly developing countries host offshored engineering, including for example the Philippines and Malaysia. An important question, given the industry’s high labour intensity and need to work closely with customers, is whether outsourcing provides the responsiveness necessary to counter the drive towards synergy and economies of scale. Consequently the whole Nordic region has tended to become a single “domestic” market.

Engserv B illustrates a particular solution with trade-off of the international synergy, local responsiveness and tension in engineering services. Local responsiveness would normally imply proximity to local customers, but Engserv B’s more important customers are large corporations with an internationalisation strategy. This means that responsiveness involves following the customer abroad. As Engserv B has a limited international office network, the synergy aspect is less difficult to handle, even if it has been a challenge for the company and led to standardising project management models and competences. Engserv A on the other hand is forced to create synergies in its large civil engineering services. Here the customer is a one-of-a-kind type, so Engserv A needs to draw on a series of offices to provide designs. Also this strategic situation coexists with another tension between global reach and extensive presence locally in a number of Scandinavian towns and cities, where providing multidisciplinary services require synergies between many small local offices.

## **CONCLUSION**

This paper’s purpose is to investigate how Scandinavian medium-size engineering service companies, coming from a tradition of working in national markets, have applied the concepts of strategic technology management and other business strategy approaches in response to the challenges faced by industry globalisation. Together with their more project oriented practices their total strategies becomes bundled of a number of elements including local collaboration and international expansion.

Both case companies have clear strategies for coping with the globalisation dynamics. They orchestrate expansions, have established more offices, and acquired other smaller and medium-size

companies in their areas of operation and interest. Nevertheless the question remains whether their expansion is being done swiftly enough to consolidate their position as independent companies or if they will instead be subsumed through the acquisition strategies of the larger engineering companies that have more comprehensive capabilities for operating globally.

## REFERENCES

Bals, L., Kirchoff, J. F., and Foerstl, K., (2016), Exploring the Reshoring and Insourcing Decision Making Process: Toward an Agenda for Future Research, *Operations Management Research*, Vol. 9, pp. 102-116. New York NY: Springer.

Barley, S. R., and Kunda, G., (2004), *Gurus, Hired Guns and Warm Bodies: Itinerant Experts in a Knowledge Economy*. Princeton NJ: Princeton University Press.

Barney, J. B., (1991), Firm Resources and Competitive Advantage, *Journal of Management*, 17(1), 99–120.

Bäumer, U., Kreutter, P., and Messner, W., (2012), Responding Strategically to Fundamental Changes in Professional Services: in Bäumer et al (eds.), *Globalisation of Professional Services: Innovative Strategies, Successful Processes, Inspired Talent Management, and First-Hand Experiences*. New York NY: Springer.

Betz, F., (1998), *Strategic Technology Management*. New York NY: McGraw Hill.

Blessmann, S., and Savelberg, A. H., (2012), Taking an Active M&A Role in the Consolidation of the Engineering Sector, in Bäumer et al (eds.), *Globalisation of Professional Services: Innovative Strategies, Successful Processes, Inspired Talent Management, and First-Hand Experiences*. New York NY: Springer.

Brock, D. M., and Siscovick, I. C., (2007), Global Integration and Local Responsiveness in Multinational Subsidiaries: Some Strategy, Structure, and Human Resource Contingencies, *Asia Pacific Journal of Human Resources*, 45 (3), 353-373.

De Wit, B., and Meyer, R., (2014), *Strategy: An International Perspective*, 5th Edition. Boston MA: Cengage Learning.

McIvor, R., (2010), *Global Services Outsourcing*. New York NY: Cambridge University Press.

Messner, J. L., (2008), Offshoring of Engineering Services in the Construction Industry, In *The Offshoring of Engineering: Facts, Unknowns, and Potential Implications*, W J Spencer et al (eds.), pp. 137-148. Washington DC: National Academies Press.

Hagedoorn, H., and Guysters, G., (2002), External Sources Of Innovative Capabilities: The Preference for Strategic Alliances or Mergers and Acquisitions, *Journal of Management Studies*, 39(2), 167-188.

Hätönen, J., and Eriksson, T., (2009), 30+ Years of Research and Practice of Outsourcing - Exploring the Past and Anticipating the Future, *Journal of International Management*, 15 (2), 142-155. Amsterdam Netherlands: Elsevier

IBIS World, (2016), Global Engineering Services Market Research Report. Los Angeles CA: IBIS World Industry and Procurement Research Reports.

Koch, C., and Bennett D. J., (2013) Taking Engineering Services Offshore - The Scandinavian Experience, In High Performance Manufacturing - Global Perspective, X Wu et al (eds.), pp. 155-159. Cambridge UK, IfM University of Cambridge.

NAICS., (2012), Industry Statistics Portal, North American Industry Classification System: 54133 - Engineering services. Washington DC: United States Census Bureau.

NASSCOM, (2006), Globalisation of Engineering Services: The Next Frontier for India. New Delhi India: National Association of Software and Service Companies / Booz Allen Hamilton.

STD., (2002-2016) The Sector Review, detailed sector survey and market review of the consulting, engineering, and architectural groups in Sweden and the Nordic countries along with an international outlook. Published annually in December. Stockholm Sweden: Svenska Teknik och Design Företag. <https://www.std.se/in-english/sector-review>

STD., (2016), Sector Review – A Swedish, Nordic and International Survey of the Consulting Engineering and Architectural Groups. Stockholm Sweden: Svenska Teknik och Design Företag.

Technavio., (2014), Global Engineering Services Market 2014-2018. London UK: Infiniti Research Limited.