From integrated enterprises to regional clusters: the changing basis of competition

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Abstract

As manufacturing becomes a truly global affair, the basis of competition will no longer be between individual companies and their supply chains but between regional industrial clusters. Large multi-nationals can relocate operations to any part of the world, with significant impact on the regions into and out of which they move. This has significant implications for economic development in any regional economy. A new form of competition has come into being, namely, that between different regions of the world seeking to attract and retain manufacturing bases of multi-national companies. The strengths of the regional clusters — networks of interrelated businesses and other organisations — influence the multi-nationals in their location and sourcing decisions. This paper discusses the nature of clusters, giving illustrative examples from several parts of the world. Nevertheless, the cluster concept is only partially understood. Many questions concerning cluster development need to be examined. A brief discussion of the operations management and IT issues within clusters, as opposed to within individual member companies, is given. The paper presents a research agenda. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Industrial engineers have had to make several mindset changes over recent decades. Those who are now in the mature stages of their career grew up in an era in which the efficiency of the integrated plant was the paramount concern. In those days, companies tended to make most of their components and assemble their products themselves. Industrial engineers were concerned with how to design and operate integrated enterprises. In the 1980s and 1990s, companies out-sourced a much larger proportion of their components and assemblies. They became extended enterprises and the supply chain became the unit of focus. Competition was between supply chains. Supply chain management (SCM) became a major management skill. Industrial engineers are as concerned with organisng supply and distribution networks as they are in what goes on within their own factory. Nowadays, the vast majority of workers are in small and medium sized companies. This contrasts greatly from the scene, which older industrial engineers will remember, common in the 1950s and 1960s, when at 5 pm, the whistle blew, the gates...
of the factory opened, and thousands of workers rushed out to waiting buses or trains to take them home to every part of the district. Companies have evolved from being an integrated enterprise, to extended enterprise to, in some cases, virtual enterprises.

Now that industry has become truly global, large multi-nationals can relocate operations to any part of the world, with significant impact on the regions into and out of which they move. While competition is still between the major extended enterprises and their supply chains, at another level, there is a new form of competition, namely competition between the regional clusters, which could contribute to the multinationals’ global activities.

This raises issues, not just of enterprise management, but of economic development. The competitiveness of industry in any region of the world will depend on the region’s total business infrastructure, which will attract companies to the region and retain them. The agility of individual manufacturers depends to some extent on the strength of these regional infrastructures. This shift in the basis of competition requires managers to re-examine their assumptions about competitive strategy. In particular, they must recognise the inter-dependence of all the stakeholders in the economic infrastructure of their part of the world. These stakeholders include government, academic institutions, research establishments, financial institutions, and many more.

An international working conference on Strategic Management of the Manufacturing Value Chain in August 1998 [1] concluded that:

1. In the new millennium, competition will be between clusters of companies, customers, suppliers, and other private and public stakeholders (as illustrated above) rather than between individual companies.
2. Emerging information technologies (such as Internet, Intranet, and Workflow Systems) will provide the technological infrastructure that will facilitate the integration of various organisations into an effective and efficient cluster.
3. Research, taking an integrated systems approach, should be undertaken to create a managerial knowledge base for efficient and effective management of integrated cluster systems.

1.1. Objective

The objective of this paper is to identify and explain the characteristics of competition between clusters. The paper also aims to explore the interactions between the operations management of companies and the operations management of the cluster itself. Strong well-managed clusters facilitate competitive companies, and promote wealth creation in the region concerned. Research issues are identified.

2. The nature of clusters

Although the term “clusters” has only recently become commonplace, we are all familiar with several clusters, such as the electronics industry in California, timber products in Sweden, or clothing and fashion trade in Northern Italy. A cluster is a network of companies, their customers and suppliers of all the relevant factors, including materials and components, equipment, training, finance, and so on. It extends to educational establishments and research institutes that provide a large part of their human and technological capital. They are all stakeholders in the end market, influenced by globalisation, commercialisation, skills development, inward investment, start-ups, and trade development.

In recent years, there has been much discussion of extended and virtual organisations. The cluster concept extends and transcends this discussion. The entire cluster is a form of virtual enterprise. Frequently, some components of a cluster will serve several industries and can be members of several clusters. For example, companies in the display technology business may be part of an electronics cluster, a defence cluster, and an entertainment cluster.

The theoretical basis of the cluster concept, as a factor in competitive advantage, was put forward by Porter [8]. He argued that the strength of a cluster depends on several interacting factors, which can be grouped under four headings (Fig. 1):

- Firm strategy, structure and rivalry
- Demand conditions
- Related and supporting industries
- Factor conditions.
Three of these are somewhat self-explanatory. Factor conditions relate to climate, labour supply and skills availability, presence and strength of research establishments, taxes, government incentives, wage levels, cost of living, and so on. The interplay of all these factors (indicated by the arrows) promotes or hinders business success and economic development in any region. For example, in the electronics cluster in Austin, TX, these factors are represented by the following:

Firm strategy, structure and rivalry: there are some 400 companies and the largest concentration of software and semiconductors in America.
Demand conditions: there is a strong local base of technologically sophisticated buyers.
Related and supporting industries: a fast-growing venture capital network, strong research base and upstream suppliers;
Factor conditions: above average education system, low taxes, low unionisation, low cost of living, and a high quality of life.

Another way of describing a cluster is to develop a map of interrelated industries. For example, Fig. 2 illustrates the Swedish timber products industry.

### 3. Arizona’s cluster approach

Arizona is often mentioned in the cluster context [7]. Arizona’s State Government has made clusters a central plank of its economic development strategy. The aim is to enable a vital cycle to begin generating more competitive businesses and creating wealth for the community from new jobs, taxes, purchases, volunteers, and contributions. The State Government concentrates on promoting seven “foundations” that create an environment conducive to economic development:

- Human resources
- Capital
- Quality of life
- Technology
- Tax and regulation
- Information and communications infrastructure
- Physical infrastructure.

Four criteria have been established for identifying clusters and selecting industries that may be eligible for government support:

- Presence above national average
- Growth rate above national average
- Export orientation
- Interdependence among member firms, including large and small companies, their suppliers, and their geographical grouping

By the end of July 1998, 11 clusters had been established:

- Bio-industry — products and services to provide healthcare in Arizona and medicines, technologies, and research for export.
Environmental technology — businesses that create and provide products and services that utilise technology to (a) monitor, eliminate, control, treat and prevent pollution, and (b) conserve and restore natural resources.

Food fibre and natural products — growth, processing and distribution of plant and animal products including edible crops, wine, cotton, livestock, processed foods, and forestry products.

High technology — products and systems for commercial aeronautics, space markets and the military, industries include aircraft and aircraft parts, aerospace instruments, missile systems, defence communications and detection systems, materials and component suppliers to other manufacturers; also includes computer industries, semiconductors, electronic equipment industries, telecommunications and professional services.

Minerals and mining — development, processing and supply of natural mineral resources and energy.

Optics — business and research of optical science and engineering for applications in health, space, military, manufacturing and environmental science, strongly allied with university research programs.

Senior living — businesses and services that attract retired persons to relocate to Arizona and support industries which serve the retirement community, such as medical, financial, legal, real estate and accounting industries.

Software — businesses that develop, market or distribute software products for business, scientific and personal use, includes products that work on a wide variety of hardware platforms including consumer electronics, personal computers, workstations, mini-computers and mainframe computers.

Tourism and experience — recreational and visitor facilities and services built around Arizona’s natural beauty, includes cultural, historical and natural attractions, amusement parks, eating/drinking establishments, lodging and resort facilities, film production, entertainment services, sports and recreational attractions and traveller and transportation services.

Transportation and distribution — physical infrastructure, capital goods and services needed to carry passengers and deliver tangible products locally, regionally and globally via air, rail, roadway and pipeline.

Plastics and advanced composite materials — companies producing these materials, including newer types of materials, which are widely used in many industries.

The numbers and names of the clusters are dynamic. The plastics cluster was established only in July 1998. The high-technology cluster had been formed by a merger of the former aerospace and electronics clusters; the possibility that this cluster might subdivide again was being considered.

The State Government does not impose any particular way of working on the clusters, instead, it gives assistance and encouragement to the players in an industry to get together. The Arizona clusters are led by industrial personnel and are principally a forum for networking among companies with interests in a particular sector of the economy. One outcome is that companies recognise that, although they may be competitors in some aspects of their business, they have many common interests. For example, several small companies have discovered that together they can bid for large contracts that they could not hope to win on their own.

It can be seen that there is a degree of overlap in the enterprises that might be members of a cluster or activities that might be undertaken within a cluster. There is no conflict in this. Each cluster focuses on a specific market or economic sector. Thus, there could be clusters of clusters and clusters within clusters.

4. Scotland’s approach to cluster development in a regional economy

As with the other regions, Scotland has to cope with a legacy of declining traditional industries while building up viable clusters in the industries of tomorrow. A century ago, Scotland had the strongest cluster in the world in the shipbuilding industry, in which the manufacture of steel, pumps, diesel engines, etc., all played a contributory part. The phrase “Clyde-built” became a by-word of dependability. Scottish engineers were to be found on vessels all over the world (a descendant became engineer of the Starship Enterprise).
The electronics industry, which is a large sector of the Scottish economy, forms one of the modern clusters. Most of the major OEMs are present in Scotland’s electronics industry. Almost half of the PCs sold in Europe are assembled here. A substantial support industry has grown up to support the OEMs, including plastic moulders, packaging suppliers, sheet metal companies, and a wide range of subcontract assemblers. One of the weaknesses is that so much of our electronics industry is foreign owned. Therefore, these companies could migrate to other regions, such as Eastern Europe, depending on world economics, unless embedded into a strong cluster here.

Scottish Enterprise, the body charged with economic development in Scotland has adopted a cluster strategy [10]. A recent study found that, of 30 or more identifiable industries, 13 industries were potential clusters, including information industries, multi-media, value-added engineering, chemicals, forest products, financial services, tourism, and education services. Scottish Enterprise has established four pilot clusters. These are semiconductors, oil and gas, food and drink, and biotechnology. The first three of these are already major sectors of the economy, while the fourth is a fast growing sector. The semiconductor industry (Fig. 3) has sales of around US$3 billion per year, representing about 2% of the world market. The industry as a whole is strong here, but within this situation, there are weaknesses. For example, although our electronics industry consumes about US$5 billion of semiconductors annually, few of these chips are made in Scotland. Those made in Scotland are exported to plants in Europe, America, and elsewhere.

Among factor conditions influencing economic development, Scotland has many advantages, including good higher education institutions, world class research groups, benign climate, plentiful clean water, good quality of life, and a strong sense of cultural identity.

5. Some international observations

The author is leader of a Technology Management educational programme, which includes an overseas study mission. Study tours have been made to California, Singapore, Korea, Arizona, and the Basque Country of Spain. Thus, the author has had the opportunity to observe developments in several parts of the world. Although not all of these visits focussed mainly on clusters, even in those regions...
studied where clusters was not a principal objective, relevant observations could be made.

5.1. Korea

Korean industry is dominated by the Chaebols — the large conglomerates now being restructured following the Asian financial crisis. Korean companies have addressed global mass markets. Consequently, several Korean manufacturers are among global household names. Competition between the Chaebols and national rivalry with Japan has been the major factor in Korea’s development, as was American assistance after the Korean War. Following the Korean War, there was high demand for many capital, and later consumer, products, which provided an engine of growth. The emphasis of technology development has switched from process technology to product technology, reflecting a change in priority from creating to exploiting manufacturing capability. National and company research programmes have very clear commercial objectives. Government policy encouraged the formation of clusters of OEMs and suppliers for particular industries in particular cities, thereby generating local clusters. Most of the companies visited made extensive use of joint ventures to gain technology for new industries. Most of the companies had very clear targets about where they aimed to be relative to competitors by year 2000 or 2005.

5.2. Singapore

In Singapore, the government influence over inward investment, focusing on high value activities with tax holidays and other incentives, was one of the principal observations. Through the Economic Development Board, the government has had a very strong influence in building up indigenous companies and in ensuring that inward investing companies bring high value activities to Singapore. Many companies are seeking to become regional headquarters, focussing on design and project management, moving low added-value activities offshore to lower wage economies, such as Malaysia, Thailand, or Indonesia. High staff turnover adds to managerial difficulties and pressure to divest low value-added work. These observations might lead one to conclude that clusters are not important in Singapore. However, the Economic Development Board has been actively promoting certain industries. Consequently, Singapore has been described as the disk drive capital of the world. The semiconductor industry has been also strongly encouraged.

5.3. Basque Country of Spain

The Basque Country is home to a significant proportion of Spain’s manufacturing industry. Represented are industries that have died out in many Western countries. Whereas, many countries compete for inward investment by multi-nationals (and Scotland has been very successful in this), the Basque Country industry is predominately indigenous. One of the major questions is how this has been achieved. There is a culture of mutual cooperation in the Basque Country. The Mondragon Cooperative has developed from very small beginnings in the 1950s to become a powerful industrial group, including world class companies in many industries. Whereas, many Western companies have moved up the value chain and given up high volume standardised production, the Basques have succeeded in also developing industries that compete principally on efficient supply of component parts to world class OEMs, such as in the automobile industry. They have also developed a significant process equipment industry. This Basque culture of developing inter-related businesses, which has some similarities to the Chaebols in Korea, is a strong validation of the cluster concept.

5.4. Arizona

Arizona’s approach to cluster development has been described above. To its surprise, study team did not conclude that the cluster policy had had a large impact. They thought that factor conditions, e.g., climate, availability of land, and the general strength of the US economy, might have had a stronger influence. However, they agreed that the cluster approach had helped many small businesses to achievements that, on their own, would have been unattainable.
6. Operations management and IT issues

While the concept of clusters is well developed in the fields of economics and industrial development, the operations management and supporting IT issues within clusters (as opposed to within individual member companies) have been given little attention. Indeed, whether there are issues that relate to the cluster as a whole, as distinct to its member companies, is an open question.

6.1. Observations on cluster operations

Some insight may be obtainable by observing the operations of clusters in several regions of the world and identifying how their operations are carried out.

In Arizona, the cluster is primarily a networking organisation for companies, especially small companies. Each cluster is led by a chairman who is an executive of one of the companies. Breakfast and evening meetings are typical events. By this means of networking, mutual business opportunities may be identified. Representations may be made to State Government on taxation policy and so on. Training and education programmes may be established at local colleges and universities. As the Executive Director of the Governor’s Strategic Partnership for Economic Development (GSPED) put it, the purpose of forming clusters is to promote “co-opetition”, including co-informing, co-learning, co-marketing, co-purchasing, and co-production.

In the Basque Country, some clusters are more active than others. GAIA, the electronics industry cluster, is most active and has a very dynamic director. The cluster has its own offices including training facilities. It is funded by a modest membership fee, by fees charged to companies for specific studies undertaken on their behalf and by grants from the Basque or Spanish Governments for specific projects. In addition to the general networking activities typical of the Arizona clusters, GAIA has an important technical role. It may take the lead in identifying research needs and opportunities and bringing together consortiums of companies and research institutes to bid for European research projects, etc. Several research institutes, incubator units and science parks have been established in the Basque Country in the past decade. The combination of these organisations, the clusters and SPRI (the Basque industrial development organisation) seems to be having a significant impact on economic development in the region. However, apart from the technical role, the Basque clusters have no operations management role and no specific IT facilities to support operations management of member companies.

In Scotland, Scottish Electronics Forum (SEF), the former JIT Club and its successor Supply-chain Partnership for Empowering Economic Development (SPEED) play similar roles to the Arizona clusters in promoting networking and discussing common issues. With Scottish Enterprise (the economic development agency), they also have a role in supplier development, i.e. encouraging local companies to establish capabilities of producing a greater proportion of the needs of OEMs in the region. In this role, the cluster itself gets involved SCM issues indirectly.

In the electronics industry, local suppliers have done well in securing a share of OEMs’ purchases. However, as industry becomes more global, more of the sourcing decisions may be made at corporate headquarters. A recent development is the advent of “supplier hub” companies, often logistics companies, which take on a management role in the procurement and supply of materials to OEMs. These companies, which include multi-nationals, are often given some autonomy for sourcing decisions by the OEM. Thus, the emergence of supplier hubs may restrict the ability of small local suppliers to gain a share of OEM procurement spend [3].

6.2. SCM

SCM is a very large field, in which logistics, operations management and IT issues are prominent, but even in this field the cluster concept is not often mentioned. Most commentators and researchers still adopt the viewpoint of a predominantly linear supply chain from material producers, component makers and contract assemblers to OEMs. Few models adopt a genuinely network approach and very few go beyond supply of physical materials and take into account the supply of manpower, capital, equipment, research, and so on. IT, GroupWare and e-commerce developments being implemented in the SCM field can be extended to the cluster, but whether the cluster itself can or should play a major role is not clear.
There is a drive towards cooperative supply relationships, including providing suppliers and/or customers with direct access to company’s IT systems. Despite this, there is still plenty of evidence that many companies still deliberately restrict the amount of information given to customers or suppliers, even though to do so might facilitate their own scheduling and logistics problems. Coll, et al. [4] gave several examples. They utilised GRAI grids [5] to model key elements of the production management system of each company in a number of supply chains. In addition to not communicating freely, they found that companies often had incompatible decision periods and horizons.

6.3. Cluster network structures

These raise issues about the ownership and sharing of knowledge on operations networks. Ferdows [6] gave an interesting view on generating and sharing knowledge in global operations networks. He was thinking about company networks, but the concepts can be extended to cluster networks. He classified knowledge networks by two factors:

- the extent to which operations knowledge can be codified (its tractability), and
- the speed of change of operations knowledge.

He mapped out the structure of the network with regards to the role of the centre (usually the company HQ) and the outlying members (such as operating units in different countries). He argued that when knowledge changes slowly and can be codified, the centre would be dominant, while if it changes rapidly or is tacit rather than tractable, the outlying members will be more important. Fig. 4 gives his diagram, with the name of representative organisations for each case.

Most cluster organisations will take the form of the slow, tacit group, as in Arizona. However in Spain, GAIA, with its role in coordinating research projects, is close to the fast, tacit group. Supplier hubs, which may be given substantial autonomy in sourcing components for OEMs, could get involved in product development decisions and conceivably get involved in research projects. A cluster organisation taking on these supplier hub roles might evolve towards the fast, codified group. One could speculate whether a cluster organisation could evolve towards the slow, codified model. If so, it would be likely to provide basic central services to its member companies, covering the range of activities mentioned above under the heading of co-opetition, with its own IT systems linking to those in individual companies. This might lead to the evolution of enterprise resource planning (ERP) systems into cluster resource planning (CRP) systems. However, it remains unlikely that the member firms would be willing to cooperate so fully.

7. Research agenda

Although the cluster concept is now quite widely recognised, it is still just a concept rather than being supported by a well-defined body of knowledge. There is a need for research to put flesh onto the concept and establish operating principles and guidelines. A fundamental question is whether a cluster amounts to more than the sum of the member firms. Can a cluster have a life of its own and add value to its member firms? Some of the research questions are

- Concerning the creation and nature of clusters:
  - Is there a formal definition of an economic cluster? Can a formal definition be developed,
which would be both robust and widely applicable?

- Are there certain fundamental criteria for the formation or existence of a cluster? For example, are the Arizona criteria widely applicable?
- Are specific environmental conditions necessary for the successful existence of a cluster? These could include market factors, government policies, employment practices and skills, global competition, etc. A recent study concluded that local factor conditions in any region are likely to have a major influence [2].
- Can clusters be created or do they just emerge as a result of actions of a large number of players? A recent technology management study tour of Arizona [7] concluded that Arizona’s successes seem to depend very much on factor conditions, such as climate, over which we can have little influence, and the general buoyancy of the American economy.
- What is the role of governmental agencies in cluster management? The extent to which governments become directly involved in such matters varies tremendously. In Arizona, the government adopts a minimal role, seeking to create an entrepreneurial climate through low taxes and low regulation. In other regions, governments seek to lead the process.

Concerning the operations management of clusters:
- How are the competitive and collaborative aspects of companies within a cluster to be managed? Is this analogous to a benchmarking club or is it a deeper relationship? Can specific mechanisms be developed to manage competition and collaboration between cluster member firms?
- How should cross-cluster issues be managed, e.g., where a company may be a member of several clusters? Are sub-clusters viable, e.g., a semiconductor sub-cluster within an electronics cluster?
- Can a cluster have a strategy (manufacturing or business) in the way that an individual firm can have a strategy? Can the various models in the literature be applied to clusters? For example, can a cluster as a whole migrate towards the high-value end of the market, or should it maintain coverage of the entire market spectrum?
- Can strategies for establishing a wide set of core competencies among member firms be developed, so that individual firms do not need to possess too wide a range of skills?
- Is there a specific role for the cluster in knowledge management of both itself and its member companies?
- Can cluster organisations take on logistics and SCM in support of their member companies?
- Are there specific ways in which the members of a cluster can take advantage of IT, www, etc., in a way that goes beyond that which an individual company could pursue? Should clusters develop IT systems designed to support the specific needs of the cluster as a whole?
- How is the performance of a cluster to be measured? How can such measures be deployed to individual firms within the cluster?

Some of these issues are fundamental, while others are of secondary importance. No doubt, other commentators could extend this list.

8. Conclusion

As integrated companies have evolved into extended enterprises, and the major corporations operate on a global scale, competition will be increasingly between regions of the world, seeking a share of the economic activity these corporations generate. Competition will be between regional clusters of inter-related organisations that add value through cooperation, rather than between individual firms and their supply chains.

How this will affect operations management and IT has not yet been examined to any great extent. The paper has identified some aspects of cluster operations management and suggested possible developments. A research agenda has been proposed.

References


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