Collaborative Manufacturing Networks
- A study of success factors

Andreas Sandgren*
Department of Industrial Engineering and Management
Jönköping University, School of Engineering
P. O. Box 1026
SE-551 11 Jönköping, Sweden
Phone: +46 36 15 78 69
Fax: +46 36 34 03 75
E-mail: andreas.sandgren@ing.hj.se

Mats Winroth
Department of Industrial Engineering and Management
Jönköping University, School of Engineering
P. O. Box 1026
SE-551 11 Jönköping, Sweden
Phone: +46 36 15 62 12
Fax: +46 36 34 03 75
E-mail: mats.winroth@ing.hj.se

*Corresponding author

Keywords: Collaboration, Success factors, Suppliers, Manufacturing networks

Abstract

Why should companies leave their independence and enter close collaboration, perhaps even with companies with similar competence? The next question is which factors are most important when creating efficient supply networks? Technical foresights and roadmaps exemplify several things that are important to work with to be successful in the future, such as to have an environmental consciousness for product and production. It is also important with collaboration between suppliers as a mean to become more interesting as partners for systems integrators. This is a process for small and medium sized enterprises in their efforts to meet the increasing global competition. Collaborations between independent enterprises are however not easily created. Several factors will affect suppliers’ ability to create these collaborative networks and make them strong enough to enable competitive strength towards threats from actors on the global market. This article describes the most important success factors for these collaborative networks.


**Introduction**

Due to increased globalization and more keen competition from other countries, many of the Swedish Small and Medium Sized Enterprises (SMEs) need to develop to meet the new demands from globalization in the world. Reasons why they need to develop are that bigger companies move production to low cost countries, rationalizations, and consolidations of manufacturing (Askman, 2004). Lack of development also leads to difficulties for the suppliers on the market. A German study shows that it is possible to maintain manufacturing in countries that are not low cost countries for manufacturing (Pfaffmann & Stephan, 2001). The trend is that suppliers go towards a more complex manufacturing and often they support their customers with a more comprehensive systems solution.

The purpose of this paper is to describe which factors Swedish suppliers in collaborative networks have to focus to be a global competitor for the future.

The evolution of manufacturing has always continued. In the beginning of the 20th century, mass production was in focus and in the beginning of this millennium mass customization and personalization were the popular buzz words. The next step could be sustainable production (MANUFUTURE, 2003) and in order to reach this type of manufacturing, several issues have to be fulfilled. The focus is clean products that are made for the environment. In order to reach clean products for the environment nano, bio, and material technology (IMS, 2001b) are important and this new technology, together with new developments, needs a production system that handles new technologies which satisfy the customers.

Many new technologies will be important for the future, but also many challenges for manufacturing are important (NAM, 2003). Companies need to be lean and efficient in order
to become competitive. To do those things, suppliers need to have production system that can handle innovative manufacturing processes and products.

**Foresight**
Manufacturing industries today face global competition which companies who want to be successful need to meet. Christopher (1998) identified an amount of changes during the last years. These changes manage:

- Customer service
- Time compression
- Globalization
- Organizational integration

*Customer service* has been a very important element that is in focus for the customer. Companies that are reaching a competitive advantage through customer service are companies that focus on logistics in their own organization. *Product life cycles* are shorter than ever and require that the time for product development and manufacturing is reduced in order to meet customer’s demands. The new demands require new ways of thinking and working with the product realization. The third point that had been in focus is *globalization*. A global player has different customers. The problem is that customers have different demands that require a flexible production system in order to perform necessary changes that satisfy different customers around the world. These three dimensions of change also require that the *organizational integration* is managed properly. Organizational integration is important in both the own organization as well as in the integration between customers and suppliers. The integration is very important in order to reduce the lead-time and to offer the customer a short delivery time (van Weele, 2002).
Customers have many demands on their suppliers. Usually they want suppliers to improve, which in turn will lead to improvements of the customer’s own production and financial result. Customers often also want good customer service and quick response. That affects manufacturing so that the product’s life cycle is dwindling and the limits are tighter, such as shorter time-to-market and improved quality. Today the focus is more and more on reduced time-to-market and on the ability to develop designs for the entire life cycle of products (VMC, 1998).

The European industrial structure is quite dominated by SMEs. This gives several advantages (e.g. flexibility, innovativeness), but it could also be a weakness (such as reduced export impacts) (MANUFUTURE, 2003). The problem for European industry is that competition from low-cost countries that mass-produce consumption products is very difficult for European manufacturers to handle. Most countries in the EU have high labor cost and the trend is that the manufacturing is shifted towards low and middle cost countries (MANUFUTURE, 2003). This means that manufacturing is transferred from EU to other countries, which could be a problem if new, more qualified, jobs are not created. These jobs include for instance manufacturing and product development.

It is possible to show if a company is successful through production advantage or value advantage or if there is a combination between these two (Christopher, 1998).
Figure 1. Value and Productivity advantage (Christopher, 1998)

There is not a good position for companies that are positioned in the lower left corner and for these companies there are two ways to change position. One way is to go up in the matrix, see Figure 1, and the other way is to go further to the right. The way to the right against Cost leader is not often usable because there is always someone that could produce to a lower cost. The other way up in the matrix leads to Service leader. Customer service is something that is expanding and in this case it is possible to achieve a better competitive position.

There are different ways to go to improve the possibilities for success. Since it could be hard to compete with the lowest price, other aspects of adding customer value could give competitive advantages (Christopher, 1998). These other aspects of value adding call, however, also for good performance of the production, such as to reduce waste (Womack & Jones, 1996). It is also possible to combine several opportunities to be more competitive on the global market and to survive in the future. One way is to change manufacturing to a more complex and high-tech manufacturing (IMS, 2001b). In this case, it is an advantage to use simulation and to build a model to determine in advance how a new production system will affect the manufacturing (IMTI, 2000). This often means that the companies need money to
be able to work with models and simulation. Smaller companies can often not afford large investment in simulation, modeling, and in new machinery. Therefore it is an opportunity to collaborate with other smaller companies, where they could be successful. The collaboration could be performed in many ways, e.g. in alliances with other companies. It could also be in different kind of networks (IMS, 2001a). The size of these networks, as well as the individual company sizes, could vary. The objective of a network is that small companies will have an opportunity to compete against the larger companies.

Another issue that will affect companies is environmental changes. Most of the changes will come from regulations, but the market could also have demands on using environmental friendly material (MANUFUTURE, 2003). Improvements in this area include both process and product. It is possible that the process has to be altered in order to meet the environmental regulations. On the other hand, if the process is based on new technology, it is possible that the regulations already are fulfilled. When products are a tool to reach the environmental regulations, it means that new types of technique or new types of material will affect products so that the regulations are fulfilled.

It is likely that technical innovations will remain extremely important for manufacturing in Europe (MANUFUTURE, 2003). Innovations can lead to better process and technical conditions for companies in manufacturing industry. Innovations could be important for suppliers if they improve the production system or introduce more products for companies in the EU that are able to produce for the market. Today there are too few innovations in the EU to be competitive. It is necessary that the level of innovations increase in the EU, if not the European industries will lose some of it potential to compete against other parts of the world.
The problem is that European companies do not invest enough in research compared with USA and Japan.

**National Foresight**
Recently, the issue about moving manufacturing companies and how that affects the Swedish industry has become very critical. The difference between outsourcing of manufacturing and relocation of manufacturing has to be considered (Fölster, 2004).

From a national point of view, Sweden has problems to compete with productivity advantage in relation to other countries. One way to meet the competition is through value advantages that bring customers value through supporting steps. The manufacturing culture is also something great and strength in the global competition and that national industry should use in the competition with low cost countries (TekniskFramsyn, 2000). Also the environmental awareness is something that is in favor of manufacturing. One weaker part is the geographic position in the world. It is a problem because it will lead to an increase of the transportation, which in turn leads to higher transportation costs and longer lead-times in the distribution processes.

The reason why manufacturing is moving to countries that have low worker wages vary (Fölster, 2004). One reason is that the company wants to focus on its core business. Other reasons are that the company wants to reduce its costs, get more flexibility, or risk reduction. Bengtsson and Berggren (2002) agree and emphasize that these are the main reasons why companies move their manufacturing. With an increased flexibility, the ability to act quickly to changes of the market increased and at the same time the company reduced its risk by avoiding investments in the production system. When manufacturing is moved there is a risk
that the company looses most of its manufacturing competence and the communication with a subcontractor becomes much more difficult (Bengtsson & Berggren, 2002).

All the global and national changes that affect manufacturing companies call for the following issues to be handled:

- **Production system** that is fast and flexible and able to handle customers’ changes in short time horizon.
- **Highly skilled organization** that can handle the necessary speed of the production system which is a result of the increased competition and the demand for innovations
- **Cooperation and alliances** is one way to be more competitive for SME suppliers in the future and these SMEs need to find ways of collaborating in these new settings.
- **Innovations** are important in order to achieve new products and productions for SME suppliers.

**Success factors**

It is necessary to have a high *flexibility* and a good *distribution* in order to handle the production system in a good and customer friendly way. Flexibility often implies speed in different ways and supposes to be the difference between success and failure. Flexibility can be a way to be prepared for known and unknown changes that will appear. Distribution is another factor and also this factor is important for the speed. If flexibility is important for the speed inside the factory then distribution is important for the speed outside the factory and the way to the customers. It is important to work with the logistics partners to find out how the distribution will be organized. Distribution could be organized through third-party-logistics or the company could organize the distribution themselves. *Organization* is important in order to accomplish the speed that the company needs. Without an organization which is able to handle changes quickly it is hard to have a flexible production. With a highly skilled
organization it is possible to handle changes in the production system without very much in-built flexibility. The organization also must be able to handle cooperation in different solutions of companies, such as alliances and networks of companies. It is difficult for a company to know when they are skilled enough. If a company is skilled enough depends on each company’s situation. It is always good for a company if the organization have a good knowledge in production system. For coming changes it is good to have knowledge about environment and how to fulfill customers’ demands. Cooperation and different types of alliances and networks for companies to work in are important from a national view. One way of cooperation that has been discussed as one solution is virtual organization among suppliers. Problems with this type of cooperation are how they will be put together and how they will be managed. For a single company there are some issues over how well the company will fit into a virtual organization or a network of companies. How well companies fit depends on several things, e.g. the contribution of the company into the network and the organization of the network or cooperation. Innovations are important for product development and realization. It is possible to see that the EU and Sweden have fewer innovations than our competing countries. In order to meet the competition from low cost countries, it is necessary to emphasize innovations so that new products can be developed and that manufacturing system can progress. Acting in a product realization network on the global market requires efficient control over the information handling. Sorting the information in order to select relevant and important information is a crucial task that SMEs might have large difficulties to carry out. Not only roadmaps and foresights show the importance of these factors. Also different test for rating production are using some of these factors (Berman, 2002; Goodson, 2002).

The success factors can be summarized as follow:

- Flexibility
Discussion
It is necessary to be flexible in order to meet customers’ demands. Flexibility is one factor that a production system will have to work with in the future. Flexibility has been discussed in many roadmaps (IMS, 2001b; IMTI, 2000; MANUFUTURE, 2003; VMC, 1998). It often stands for speed in different ways and supposes to be the different between success and failure. Flexibility can be a way to be prepared for changes, planned as well as unplanned, that will appear. To be able to do all these things, companies need to have flexibility in the system. Questions that companies need to ask themselves are what type of changes they need to be prepared for and which level the flexibility will handle the changes. To be enough flexible for competing on a global market, which will be required, it is necessary to have right flexibility for the right changes (MANUFUTURE, 2003).

In a supply chain it is important that the flexibility is high in both manufacturing and in information flow, since quick response to market flexibility is one major component in order to be successful (Berman, 2002). Flexibility is particularly important for SME suppliers, because this factor is important when SME supplies compete against bigger companies.

There are different dimensions of flexibility and it is important to know which dimension of flexibility that is addressed. One example to define flexibility is according to Barad and Even
Sapir (2003). The structure consists of three hierarchical flexibility levels and it is a bottom-up logistic oriented hierarchy of flexibility (Barad & Even Sapir, 2003):

- **Basic flexibility** – this flexibility comprises flexibility of the systems components. The key components of a manufacturing system are its machines, the material handling units, and the transporting network.

- **System flexibility** – is a composite of basic flexibility types at the manufacturing system level. This type of flexibility supports decisions at a tactical level for quick response for the manufacturing system.

- **Aggregate flexibility** – represents the aggregated attributes of manufacturing system technology. It will handle the variety of changes on a strategic level, hence at a long-term range.

When you compete with flexibility it is very important to know what kind of strategies for flexibility you need. Gerwin describes different situations that need different strategies of flexibility (Gerwin, 1993). *Adaptation* represents a defensive strategy of flexibility and it often considers costs of flexibility. As the process or market uncertainties increase, flexibility grows. *Redefinition* is a proactive strategy of flexibility. A firm can encourage customers to see benefits of shorter lead times or more frequent new product introductions and then offer these higher levels of service through superior manufacturing systems. *Banking* is a strategy of flexibility that will hold flexibility for future needs. This strategy is both a defensive and a proactive strategy because it can handle fluctuations and it can help to redefine competitive conditions. *Reduction* is a proactive strategy that will reduce the need for flexibility. Environmental uncertainty could be reducing through long-term contracts with customers and suppliers. These are different strategies to handle uncertainties. Flexibility is required whether the plan is defensive or proactive.
To meet customers demand faster it is necessary to shorten the lead time. Not just in the production process, but also in the distribution process. Distribution is important for many things, like flexibility, delivery safety and customer service.

When the company describes how their own distribution should look like for the own best in the supply chain. There are some factors to consider (Jackson et al., 1982).

- Customer numbers
- Customer’s geographic concentration
- Customer’s industrial concentration
- The product importance for the customer
- Customer’s volume potential

It is also important to remember that in order to get a win-win solution it is necessary not to get a sub optimization, which is an obvious risk when a single company tries to improve their own distribution.

The numbers of customers is important for suppliers. With a low number of customers it is preferable with a short distribution chain (Gadde, 1980). Also when a company produces against customers order a short distribution chain is to prefer, since it improves feedback from the market and the customers. A short distribution chain is also to prefer when the product is in an early stage of the production cycle.

To reach the speed in collaboration it is necessary to know what type of flexibility that is required and how the distribution should be organized.
A success factor is to meet opponent quickly and decide in what way to improve the own organization. Four basic theories for changing are, *life cycle* that sees the development as a sequence of given steps, *teleology* where the change is recurrent sequence formulation, implementation, evaluation and modification of the goal, *dialectics* proceed from a thesis and together with antithesis produced a synthesis and *evolution* that consist of a continues process of changes, selections and maintaining (Van de Ven & Poole, 1995). Another way is to see what the change will do and how it best will be realized. Carlsson (2000) describes three different models for work of change.

- **Model of linear change** – the model of linear change sees the change as a sequence of steps that have to be evaluated. An important part is to collect and analyze fact in the work that will be the ground for different strategies and structure design, all that to focus on the substance in the change. The first step in a linear change is to formulate the content and after that the decision to change will be taken to do the implementation. The model of linear change separate between formulation and implementation that will make that these phases could be handled independently.

- **Model of process change** – in model of process change consider not to change through rational decision processes instead there is a need for a critical group that has influence over how an idea will be realized. The most important in this model is in the real process. A fundamental assumption for this model is that the reality is subjective and the actors from different perspectives act from those perspectives. In the model of process a change is not seen as a separate change that occurs in an organization. Formulation and implementation consider being a division by the same process. Formulation and implementation consider being the same process, because of this
there is a strong connection between both these phases. Who the formulation process will be taken care of forms the change of implementation.

- **Model of circular change** – the model of circular change sees the change as a circular learning process. A change considers to be done in cooperation between do and learn. The model of circular change has the same basic view as the model of process change. The model of process change focus on the interplay between individuals and the model of circular change focus on the interplay between handling, observation and reflection. The circular model is based on that changes are about discovering and experience. The circular model takes history in consideration and thereby it is possible to link earlier experience together with how the change should be done.

These three different models can all be used to realize a change. If a logistic change will be realized the choice depends on what the change will handle, which can be shown in this model (Carlsson & Sarv, 1997), see Figure 2.

![Figure 2. The Stair Model (Carlsson & Sarv, 1997)](image)

A small change involves a low level of change and a radical change involves a high level of change.
It is important to remember that a change that is important for one company not necessarily is important for another company (Porras & Robertson, 1993). The size of the company also affects the result of the change.

To be successful it is necessary to know how to implement the change in order to minimize the time and the effort for fulfilling the purpose of the change.

For a SME company it could be difficult to compete when you don’t have the knowledge like bigger companies. One way to improve the ability is through cooperation with other companies. Even for quick response and a good integration in the supply chain a good cooperation is important between companies (Shaw & Lin, 1998). So a success factors is to use different types of cooperation. There are several ways, in networks, strategic alliances, partnership, etc. (Danilovic & Winroth, 2005). All cooperation and alliances are not successful and Bleek and Ernst (2003) describe different situations where the cooperation could fail. Often the problem is that companies are not equally competent and thus they do not all contribute equally to the success of the alliance and they do not benefit equally from the outcome (Bleeke & Ernst, 2003). When you know how to cooperate, then it is possible to work with integration in the supply chain. In cooperation it is necessary with a transparent system that makes things easy to follow (Shaw & Lin, 1998). A good integration could also make the system work faster (Pine et al., 1993).

To be successful it is necessary to be involved early in the product development (Ragatz et al., 1997). This requires that the supplier has enough knowledge to contribute actively. Otherwise, the customers do not benefit from involving the suppliers and they will hesitate to take that step. A Greek study indicates that few product developments from SME companies are for a new market (Voudouris et al., 2000).
Sufficient knowledge is important not only in product development. It is also necessary for product realization in order to avoid problems in the introduction of the production system and the material flow. An efficient flow of material can create possibilities for better flexibility and efficiency (Womack & Jones, 1996).

To have a good product realization it is important that the manufacturing system is synchronized with the characteristics of the products that will be produced. It is possible to describe the connection between market and product characteristic and suitable material and production control (Berry & Hill, 1992).

To be successful is necessary that the information between companies in collaboration is fast and without unnecessary details. It is also important to minimize the human activities in the information handling, since they slow down the process and also introduce an increased risk for errors and problems (Jacobs & Whybark, 2000). A big challenge is to coordinate the information in a collaborative network and to clear decision path (Johansen et al., 2005).

Different information should be handling different depending on the situation and what it will be used to. It is possible to arrange information into three different categories (Gadde & Håkansson, 1998):

- *Technical* is for specify what will be paid.
- *Commercial* is for to reach a deal.
- *Administrative* is for to handle a specific delivery.

Standardization of information could have positive impact on time and costs (Gadde & Håkansson, 1998). It is therefore important to find out which information that is possible to
standardize. If it is necessary to have an information flow between several links in the value chain, the standardization of information becomes even more complex. The administrative information between customers and suppliers is one of the areas where standardization is most easily created. The main reason why this gives a fast result is that a large quantity of data is transferred and this is easiest to do in a standardized form.

**Conclusions**
When you have found the success factors for collaborative manufacturing networks it is also important to know how to use these factors in order to be successful. There is a need to know what flexibility that is needed so that the level of flexibility in the network is suitable and there is also a need to know what type of distribution structure the network requires in order to reach the expected speed. To handle this, and customers’ other requirements, it is important to handle changes quickly and to the right degree. It is also important for a company to select the right cooperation that will suit them in the long run. You know what flexibility and distribution you want and how to do it. It is then important to maintain and evolve the product development and the realization to satisfy the entire supply network. To handle all this it is important that the flow of information is well organized, so that the right information is provided on the right time, at the right location, and in the right quantity. When a company has all this success factors coordinated, they will be an interesting partner for a collaborative manufacturing network.
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