ARIKA, Vol. 04, No. 1 Pebruari 2010
ISSN: 1978-1105

COLLABORATIVE MANUFACTURING NETWORK FOR SMALL AND MEDIUM MANUFACTURING ENTERPRISES

Olivia M. de Fretes
Dosen Program Studi Teknik Industri, Fakultas Teknik, Universitas Pattimura Ambon
e-mail: df_via@yahoo.co.id

ABSTRACT

Due to the increased exposure to competition through globalisation and free trade agreements, leading manufacturers are continuously challenged to provide high quality products at similar prices that low cost countries offer. Small and Medium Manufacturing Enterprises (SMMEs) face the same pressures as large companies, but often do not have adequate resources to remain competitive and grow. Therefore, SMMEs need to innovate and find new ways to overcome these challenges. Collaborative Manufacturing Network (CMN) promises flexibility and competitive capability, particularly for SMMEs.

This paper analyses the issues, challenges and concerns faced by SMMEs in forming a CMN. Further, it explores the impacts on manufacturing industries due to the emergence of CMNs, particularly on SMMEs, since CMN challenges current business models and existing concepts.

Keywords*:Small and Medium Enterprises, Collaborative Manufacturing Network*

INTRODUCTION

In manufacturing area, new ways of doing business are emerging due to the increased exposure to competition through globalisation and free trade agreements. Manufacturers these days are challenged to continuously provide high quality products at prices that low cost countries offer. This is such a major issue for Small and Medium Manufacturing Enterprises (SMMEs) around the world as they lack of adequate resources to remain competitive and grow. Collaborative Manufacturing Network (CMN) is currently a key issue in manufacturing. As a new business paradigm, CMN may play important role in the survival of SMMEs. However, collaborative processes among enterprises are very complex and dynamic. Therefore, the issues, abstraction, challenges and concerns faced by SMMEs in forming a CMN need to be understood as it should be.

COLLABORATIVE MANUFACTURING NETWORK (CMN)

Leading manufacturers nowadays agree that the next level of business improvement will come through collaboration. Collaboration between enterprises is about working together in a close relationship for the purpose of achieving mutual objectives. Manufacturers who have focused on their core competence require partners to provide total solutions. Aim to make the entire business and supply chain processes more efficient, recently many manufacturing enterprises embrace CMN in operating their business.McClellan (2003) considers thatCollaborative Manufacturing (CM) can be initially established by removing obstacles that hinder cooperation among a small group of supply chain partners within a network. This process consists of three phases: 1) identifying and scoping the objective, 2) establishing the requirements, responsibilities, methods and approaches in meeting these objectives, and 3) ensuring the compliance or the confirmation of facts based on trust.This is the most vulnerable point of the process, where trust alone can bridge the gap between partners. Collaboration is highly dependent on business objectives. If the main purpose of the collaboration is to meet and exchange experiences, collaboration could be loose and not highly formalised, but if the purpose is to develop and produce new products, the demands on the collaborating member organisation are higher. The primary objective of CM is to reduce or eliminate the dysfunctional process through synchronising the production processes of the value chain network, which helps in lowering costs and more consistently meeting market demand requirements. This is how collaboration be distinguished with co-operation. CM aims to make the entire business and supply chain processes more efficient.

TheARC Advisory Group, a consultancy group which advocates innovative manufacturing solutions, has identified seven requirements for CM as follows:

1. Synchronization of business processes with manufacturing processes by sharing information,
2. Optimisation of the supply-side of the value chain,
3. Automation of business processes across the collaborative partners,
4. Empowering people and measuring results for value generation,
5. Implementation of systems to support collaborative processes,

6. Linking of operations with customers, and
7. Enabling collaborative maintenance and manufacturing support.

In order to have CM systems, information systems must share key information across the supply chain and the partner network. These systems must also provide a means to intelligently distribute necessary real time information across various business entities. To make the entire business process efficient, enterprises involved in CM need to establish a network as this helps to establish trust, which is fundamental in order to share confidential and key business information.Network are unusual forms of organising and are not governed by traditional hierarchical relationships, critical challenges have to be faced such as the development and maintenance of trust or uncertainties and tensions between the processes of collaboration and competition between members. Most of literature emphasise the benefit of networks, highlighting their advantages in terms of innovation, knowledge and information sharing or process effectiveness.

Johansen et al. (2005) define a CMN as "extended enterprises consisting of several companies that cooperate in a project resulting in a manufactured product, where each company has expert competencies in one or several areas". Joining networks as what have done by many manufacturing companies in this globalisation era, has a much more direct impact on business success. Winroth and Danilovic (2003) stated that companies joined in a CMN have larger opportunities as well as increase their market niche.

CMN, according to McClellan (2003), can be another way around of doing business. The most significant aspect of this idea is the change of traditional style of doing business to cooperative and then collaborative arrangement bases on identified elements of mutual interest and trust. Correspondingly, (Lin et al., 2007) believe that CM is a new business paradigm that requires manufacturing enterprises to establish close relationships, and exploit each other's core competencies in order to improve the overall business performances.

Some important reasons for collaboration in networks, according to Hanson et.al (cited in Danilovic and Winroth, 2005):

- Collaboration as strategic positioning. This includes possible specialization, striving towards a mutual objective, and complementary products or services,
- Opportunity to learn and share experiences in between participants,
- Possibility to develop and deliver more complex products than would be possible for the single company,
- Exploiting existing synergy factors in technology and product development, and
- Economic factors, such as share risk and investment benefits.

In addition, McClellan (2003) highlighted some more reasons of collaboration that are to synchronize the production processes of the value chain network so as to reduce or eliminate this dysfunctional process, by this means lowering costs and more consistently meeting market demand requirements. Also to eliminate or improve management of events that result in just-in-case inventory.

Some literature have been talking about the benefit that offered by CMN for enterprises. Lin et al., (2007) and Sherer (2003) stated that CMN can increase global market share as well as decrease production cost. It is also a learning to adapt to changing economic environments. Other positive outcome that may be achieved by the participants is the improvement in customer service and their product differentiation. Furthermore, it is possible to decrease manufacturing lead-time and increase manufacturing throughput by limit repetitively and efficiently perform their core competencies. Companies could growth strategies and entering new markets, obtain new technology and best quality or cheapest cost, reduce financial risk and share cost of R&D, achieve competitive advantage through collaboration in network and provide access to technology. From the benefits that have been mentioned above, CMN seems to be promising a way for manufacturing enterprises, especially for small and medium scale of manufacturing enterprises as they lack infrastructure and resources.

Small and Medium Manufacturing Enterprise (SMME) Issues

Small and Medium Enterprises (SMEs) has been defined differently around the world. Asia-Pacific Economic Cooperation defines SMEs across its member countries according to the phase of economic development as well as the prevailing social conditions. Various indexes such as number of employees, invested capital, total amount of assets, sales volume and production capacity are used by member economies to define SMEs. An SME that specialises in the manufacturing industry sector is considered a Small and Medium Manufacturing Enterprise (SMME) in this paper.

SMMEs form a significant proportion of the entire manufacturing industry which is the economical backbone of an industrialised country. They are highly flexible, adaptable, and specialised manufacturing enterprises. In the early phases of technology uptake, SMMEs must aware of new

technology, that is, managers or R&D specialists need to be aware of what is available. Even though SMME sector pioneers much technological advancement, employ large workforce and even influential contribution in a country's Gross Domestic Product (GDP), SMMEs are lacking an infrastructure to conduct research and development projects aiming at reforming and executing business strategies that maintain their competitiveness in the changing market (Bessant, 1999).

Different to large enterprises, SMEs focus on the problem of survival as well as development as they have not enough economic potentiality to invest in research, development and technology. They also lack some necessary physical conditions and the environment for the CM, as a result of the financial and scale limit, they can neither conduct the CM by organise status, nor have the ability to continue widespread market investigation and analysis (Berry (1997), Martin (2002) and Chunquan and Dejian (2006)). Furthermore, Berry (1997) maintained that SMMEs also limited in access to technological information, and guidance on quality control as well as their access to finance and assistance in purchase of materials or equipment. Whenever the customer and supplier shares in the profits, information sharing relies strongly on the trust between the partners. The lacking of effective observable guidance, according to Berry (1997) and supported by Chunquan and Dejian (2006)makes it difficult for the SMMEs to form industrial connection, specialised coordination and manage network, then it is unable to make use of the scale, the scope of economyand the cooperation effect that generate from the centralisation of SMMEs.

Harvie and Lee in their study on the East Asian SMMEs found that the difficulties encountered by SMMEs differ considerably in the aspects of exporting, investing abroad, industrial upgrading, industrial structure change, and developing and expanding. SMMEs in some economies, specifically the more technologically advanced, have concerns about intellectual property rights protection, particularly copyright and patenting in exporting. Other countries, such as Indonesia, have concerns with a lack of information, orientation and experience in SMMEs trading and investing abroad. Shortage of skilled labour and lack of access to loans reduce the ability of SMMEs to ensure or upgrade quality production in Malaysia and New Zealand. Despite these differences the difficulties faced by SMMEs have several things in common with respect to exporting and investing abroad, namely: a lack of information on overseas markets; shortage of funds for setting up business channels abroad; lack of experience in international business practice; and difficulties in managing workers employed abroad.

Another significant issue with SMMEs is location, for those involved in supply chains in particular. Having a network for SMMEs provides significant benefits as many are located closer to their customers(Martin 2002). In support to that, a survey by McKinsey and company showed that best practice in the world's leading manufacturers included activities which bring suppliers close to manufacturers, staff rotation and teamwork. Additionally, Bilbao et al. (2004) listed several identified issues related to SMMEs. They are:

- SMMEs are ready to exploit CM.
- In implementing collaborative working mechanism, possible cultural barriers which associated to organisational methods of SMMEs must be taken into account.
- The introduction of collaborative mechanisms should not require drastic technological evolution efforts.
- Most SMMEs up to now keep using either very limited project management tools or traditional standard tools such as MS Project, Timeline, and others.
- SMMEs need to balance the old and the new project management items.
- Collaborative project management and micro management do not coexist very well. The collaborative approach is more consensual and interactive than assigning and controlling.
- Problems still exist in data format exchange.
- SMMEs need to improve the quality of the exchange of technical data with their customer for example Computer-Aided Design (CAD) data exchange with suppliers using different CAD systems.
- Customers need to improve quality through real-time communication of product designs within their supply chain.

Despite all the pessimistic issues about SMMEs that have been talked about widely, number of researchers namely Dyer, Kale, and Singh (2001) also Elmuti and Kathawala (2001) proposed several aspects that identified as the key success factors for SMMEs. They are partner selection, clearly defined shared goals and objectives, similarity of management philosophies, frequent performance feedback, activities to build trust in the relationship, and senior management commitment.

Collaborative Manufacturing Network for SMMEs

Being a member of a well-structured and trusted CMN is a viable approach for SMMEs to compete against large enterprises or at least to remain competitive and grow. Many enterprises, including SMMEs, choose to collaborate in a network to expand market opportunities, foster growth and provide access to technology. Thus through CMN, SMMEs are able to collaboratively deliver global manufacturing solutions more effectively and efficiently. Further, strategic alliances in the form of CMN will help to achieve the SMMEs goals of rapid technology diffusion, added capacity and capability to enter new markets, ability to bypass government restrictions expeditiously, and to learn quickly from the leaders in a given field Elmuti and Kathawala (2001). In those categories, technology plays a major part in two of the four categories. The 2000 McKinsey Study on knowledge management in manufacturers found that 67% of the more successful companies surveyed established strategic alliances to gain access to partners' knowledge while only 33% of less successful companies entered into such alliances (Martin, 2002).

Driving forces for collaboration in networks can be seen from three points of view (Danilovic and Winroth, 2005):

- External driving forces – forces that emerge outside the network but influence almost every company in the field
- Strategic driving forces – actions that decide how the individual company relates to other organizations
- Internal driving forces – based on a deep structure of internal shared values within the organization

In order to participate in a CMN and have a successful network, SMMEs need to investigate three key aspects: organisational culture of the participants, availability of an interoperable framework, and a formalised framework for collaborative decision analysis (Lin et al. 2007).

- Organisational culture: following organisational-culture activities need to be conducted to support participation in a CMN.
  - ✓ Identifying core competencies of the enterprise and outsource supporting process,
  - ✓ Ensuring reliability, flexibility by acquiring multi business partners for every outsourced process,
  - ✓ Establishing agreement with business partners on the terms for collaboration (sharing risks, commitments to deliver, and compensate for failed commitments),
  - ✓ Analysing potential for making decision using online applications as well as web-based applications to perform group decisions,
  - ✓ Establishing capacity and commitment to fulfil collaborative objectives ,
  - ✓ Sharing data, information, and knowledge in supporting collaborative process,
  - ✓ Restructuring resources to optimise collaborative processes, and
  - ✓ Dedicating personnel to take a lead role for the management of this CMN.
- Interoperable framework: Establishing an interoperable framework to integrate legacy systems that may exist among the CMN members. In the selection process of an interoperable framework for the CMN, the capabilities that are to be considered include Business connectivity, Potential business benefits and costs of these systems, financial considerations for a scalable and secure systems, existing E-Government standards, forward outlook among CMN members, usage limitations, product support from vendors of these systems, technical support or staff experience among individual enterprises.
- Framework for collaborative decision analysis: In order to support the decision-making in a CMN, Lin et al. have proposed a detailed collaborative decision analysis framework (Lin et al. 2007).

It can be said that collaboration is seen as a theory that plays an important role in the survival of many small and medium sized enterprises. Fuller-Love and Thomas (2004) found that networks for small manufacturing enterprises can be a very cost-effective way compared to other strategies in improving their performance. Another result of their study indicate that networks can provide a valuable source of information and a means of sharing resources and to undertake joint projects. By exchanging information and know-how, networks can be an important tool for small business entrepreneurs to improve their businesses. Moreover, their research provides evidence that the advantages of being part of the network included personal contacts, information, ideas, problem solving and improving effectiveness (Fuller-Love and Thomas, 2004).

The CMN concept provides a framework for SMMEs to develop strategic business relationships with their manufacturing partners to enhance competitiveness and capture global opportunities. Some of the serious negative impacts of a CMN based business model are increase of management complexity and having an effective risk management strategy, as manufacturing activities must be effectively and

efficiently orchestrated among participating SMMEs.The implementation of CMN is highly complex, as business processes among collaborative partners must be managed holistically in order to fulfil the network's objectives. Hardware and software that support the management and execution of collaborative activities can be built in order to support CMN participants and achieve better outcomes. Therefore, in order to participate in a CMN, SMMEs must be committed to adopt the necessary ICT that allows them to collaborate more effectively and efficiently with other members of the network.

ISSUES WITH COLLABORATIVE MANUFACTURING NETWORK

Numerous of literatures have brought up number of issues regarding CMN. Lin, HW, Nagalingam, and Lin, G. (2007) identify three major issues present in collaborative manufacturing particularly for SMMEs as follows:

- Organisational culture
  In case of collaboration, there is no synergy analysis between SMMEs and their business partners to exploit potential. Most of their business activities with alliances can be categorised as a simple sell-buy relationship. SMMEs tend to be reluctant in sharing their information with business partners in order to protect their privilege in the associated manufacturing processes.
- Data, information and knowledge sharing
  Sharing of data, information and knowledge in an appropriate way is critical to support the operation of collaborative manufacturing. There are several important things to be considered such as the source of SMMEs such as what to share and to what extent, any chances of miss-used knowledge, if any, and how to recover. After that, the source SMME must ensure that the transferring process is done as coherently and accurately as possible. Next process is the quality evaluation of the associated data, information and knowledge.
- Legacy systems
  Legacy systems usage is widespread throughout SMMEs, as software tools are either purchased or developed in-house to address specific needs by functional units. SMMEs used to have several issues such as lack of systematic approach to ensure that all their systems are interoperable and that work processes can flow interchangeably through different systems. Lack of qualification to use software packages that possibly lead to achieving of inappropriate data is another issue related to legacy systems.

In line with Lin's work, Browne and Zhang (1999) conclude that the success of collaborative enterprises depends on information sharing. The intensive information sharing provides not only a greatly reduced time-to-market through quick-response manufacturing but also integrated and coordinated product design and manufacturing from all the participants. However, even though information sharing seems to be promising and has shown positive improvement on the company performance, important aspect that needs to be addressed is information distortion (D'Amours et al., 1999).

Besides the issues with CMN that have mentioned above, there are several others that have also identified in literature. Johansen, Comstock, and Winroth (2005) contends that there is a need for companies collaborating in manufacturing networks to develop a trust-based relationship in order to develop, produce and deliver complex products. Collaboration is something that will bring benefits to the collaborators, yet collaborations could also spell disaster. As has been shown in several literature that are available (Elmuti and Kathawala 2001, Johansen et al. 2005, and Berry 1997), without clear understanding of the issues and constraints, a CMN will possibly face increasing in risk on business information and financial failures. When CMN concept is expanded to a wider domain, some possible dangers of conflict in collaborative partnership between enterprises also need to be considered including entry and exit strategies for CMN members. Kumar and van Dissel (1996) also indicated that since collaborative activities are likely to be having an intellectual aspect, there is a high risk of losing control over resources. Further, an organisational culture aiming towards short-term outcomes and inclined towards having a competitive edge among participants can result in opportunistic behaviour by one or more participants in the collaboration. This opportunistic behaviour may lead to mistrust among the participants and can generate counterproductive actions by others. Hence, it is important that risks are anticipated and identified at the early stages of forming a CMN in order to have appropriate management strategies if future conflict occurs.

Challenges and concerns in forming a CMN

Numbers of key factors concerning the success and failure of CMN are widely expressed in the literature. In network collaboration, social and informal exchanges among participants in SMMEs are

expected to be particularly important as well as the importance of information system. for CMN include partner selection, shared goals and objectives, similarity of management philosophies, frequent performance feedback, activities to build trust in the relationship, and senior management commitment (Dyer, Kale, and Singh 2001; Elmuti and Kathawala 2001). Later, Sherer (2003) proposed five factors that expected to impact the success of the collaborative manufacturing network, namely; trust, commitment, selection choice, information technology, and intermediary support conduciveness of external environment. However, commitment and trust amongst participants are identified as the key attitudes to achieve successful collaboration for a network of participants (Sherer, 2003; McClellan, 2003).

Many SMMEs are finding it difficult to identify suitable partners for collaboration as there are no appropriate selection mechanisms or decision support systems available that can be readily used by SMMEs (Elmuti and Kathawala 2001; Sherer, 2003). The process of searching and selecting the appropriate partners is the key to the successful formation of the CMN. However, there are several key prerequisites that need to be ensured by SMMEs when selecting collaborative partners. They are, that partners (Lin 2008):

1. Demonstrate that they share the same collaborative visions and objectives,
2. Understand their niche in the CMN and how can they contribute,
3. Committed to provide unique manufacturing capabilities for the achievement of collaborative objectives while maintain their niche,
4. Willing to share critical data, information, and knowledge to facilitate more efficient management of collaborative activities, and
5. Prepared to adopt specific advanced technologies to support the management and operation of a CMN.

Overby (2005) argued that when identifying a potential partner, a company should conduct a comparative assessment of potential partners' resource potential and relative importance of aligned strategic aspirations and enterprises may benefit at certain times by being in partnership with weak resourced partners. He further states that when enterprises choose to collaborate with enterprises with whom they have common strategic aspirations, bargaining and opportunistic problems might diminish over time, and critical resources should not determine the formation of a network and may not even be the primary reason.

Trust is defined as the willingness of a party to be vulnerable to the actions of another party based upon the expectation that the other will perform a particular action important to the trust, irrespective of the ability to monitor or to control other party (Mayer, Davis, and Schoorman1995). Trust is then built on confirmation of events through information technologies. Along with trust, the construct of commitment, willingness of partners to exert effort on behalf of the relationship also has received considerable attention in strategic alliance literature.

It is possible that member of a CMN are spread worldwide in order to gain competitive edge. For this reason, SMMEs need to overcome global boundaries in terms of distance, time, regulatory constraints, cultural and political differences therefore mutually beneficial agreements on how to optimise the customer order fulfilment process can be achieved (Nagalingam and de Fretes, 2009). In order to build such a collaborative relationship, the partners must be willing to invest in people and assets that are dedicated to each other, and also be prepared to share both explicit and implicit knowledge with other companies which may also be competitors (Dyer, 2000). These collaborative relationships are, according to Dyer is a trust-based collaboration. Trust is seen as the fundamental element in collaborative relationships. In the manufacturing environment, trust comes from measuring and confirming events as they occur, and making this information available to partners. Trust is then built on confirmation of events through information technologies. The opinion of McClellan (2003) is that collaboration can be a very effective and successful business strategy, but it is not easy or simple to implement, and will require new thinking, openness, and trust. Trust is the fundamental building block of collaboration. Each partner must be able to share information without fear of being taken advantage of by the others. This includes such sensitive information as product design, cost information, and occasional performance deficiencies. In addition, (Elmuti and Kathawala, 2001) mention that building trust is the most important and yet most difficult aspect of a successful alliance, since only people can trust each other, not companies.

What is more about factors to the success of CMN are also maintained by Johansen, Comstock, and Winroth (2005) as follows:

- Companies should be ready for and be flexible to different types of inter-organizational collaboration
- Strategic choices made by collaborative partners are influenced by early participation in the concept phase, unique technology competence, and the level of shared risk

- Companies should see the trustful, win–win relationship that can occur with involvement in a CMN through the strategic utilization of each partners' competencies
- Employees are trained to use these communication systems in a proper way to support work processes and mutual decision-making
- Stay away from any potential problems during latter stages of the project by conducting cultural awareness training from the start in planning future products.

Numerous of factors to the success of CMN have been given with the support of various researchers, yet some studies that identified the problems and failures among CMN are also need to be considered. Elmuti and Kathawala (2001) draw attention to several reasons behind the failures namely:

- Clash of cultures
- Lack of clear goal and objectives
- Lack of trust
- Lack of coordination between management team
- Differences in operating procedures and attitude among partners
- Performance Risk (source: environment, market, and internal factors)

Additionally, Zineldin and Bredenlow (2003) mentioned some reasons which include difficulties in business relationship, dissatisfaction with outcome or organisation and structure of the collaboration. Another reason to fail in collaboration is that the relationship's objectives no longer match one or both partners' strategic priorities. Moreover, the lack of ability of one partner or another to organize internal resources to support the initiative could also lead to unsuccessful of collaboration. These issues are considered as challenges for a CMN.

Impacts of the emergence of CMNs towards SMMEs

Shi and Gregory (2005) in their study on the design and operational manufacturing networks to enable implementation of collaborative manufacturing had reviewed several types of international manufacturing networks. The one that suitable for implementing CMN for SMMEs are manufacturing enterprises that have unique competencies that aim to establish strategic relationships between them in order to achieve further competitive ground.

Several key business performance parameters that SMMEs and their collaborative partners expect to improve by collaborative manufacturing are global market share, business profits, and investment risk. Study of literature has shown the impacts of collaborative manufacturing network into its participants in many aspects. Lin et al. (2007) found several positive outcomes that can be achieved by the participants of CMN. Joining CMN could increase global market share of the company as well as lower the production cost. Moreover, CMN could also improve customer service and product differentiation. As well as decreasing manufacturing lead time (extended capacity), CMN also increase manufacturing throughput (limit repetitively and efficiently perform their core competencies). More benefits from participate in the CMN have been mentioned by Gatner (cited in Bilbao et al, 2004). In a study based on Collaborative Systems used 20 companies, Gatner estimated that Collaborative Systems can improve inventory accuracy by 5% to 15%, it can also reduce the supply chain operations cost by 20% to 35% and pay for itself in four to six months.

Furthermore, Ghausi (2002) found in a study that collaborative manufacturing can also affect cost of goods sold (COSG). CM can reduce COSG by reducing time to volume production, improving responsiveness to changing conditions on the supply or demand sides, facilitating the Request for Quote (RFQ) process to obtain better prices and by reducing the cost of procurement through purchasing process automation, and improving visibility to parts and assembly usage to leverage direct material contractual buys. In addition, the following case studies conducted by Ghausi show successful companies that use collaborative manufacturing solutions.

- Dell Computer:
  Dell worked with Agile to create a value chain website that connecting Dell's top 100 suppliers which represent the majority of the company's spend. As a result, 40% reduction in cycle time to apply change orders. Dell has incorporated its top suppliers into its product development process, reducing product transition cycles and improving time to volume.
- Sycamore Networks:
  Using collaborative manufacturing commerce solutions from Agile Software, Sycamore took the product concept to prototype in five weeks. They introduced three major new product lines in just 18

months. Mr. Dowling, vice president of operation acknowledges that the company's moving rocketing from design concept to assembled prototype in just five weeks.

- Dlabs:
  By reducing the turnaround from as much as four weeks to an hour or two for engineering changes, the company has reduced the time to market/volume. For the flow of consistent data, the company also has better audit capability

Ms. Lisa Koenig, director of re-engineering at IBM's Personal Systems Group (cited in McClellan 2003) stated that by implementing a collaborative system, one business unit of IBM has seen the following results:

- Order scheduling time reduced by 66%
- Channel inventory trimmed by 80%
- Supply-commit cycle time shaved by 50%

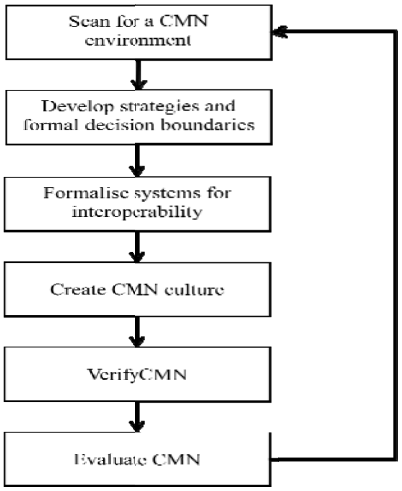
Challenges to the current business models and concepts

The current business models and concepts such as supply chain management, manufacturing, production systems, customers, and others are being challenged by the emergence of CMNs. Supply Chain, according to Christopher (2005), is the network of organisations interlinking suppliers, manufacturers and distributors in the different processes and activities that produce value in the form of products and services delivered to end consumer. This is an end-to-end process in which all channels in the supply chain can bring or share data, information, and resources with partners in order to achieve their objectives (Parung and Bititci, 2006). The only drawback is that in a supply chain, the risks and benefits are not generally shared among participants as in CMN.

Lean manufacturing concept is a popular technique for productivity improvement. However in the implementation of this concept, SMMEs are still not certain of the cost and the likely tangible and intangible benefits they may achieve. Most of manufacturing enterprises fear that implementing lean manufacturing is costly and time consuming.

Managing collaborative activities among SMMEs, who are members of a CMN, is another complex problem. Therefore, decision makers must optimise business processes of their internal manufacturing entities and open their business practices and operational systems to the members of a CMN to achieve effectiveness and efficiency across the CMN. This approach again necessitates the need for advanced ICT tools and systems to support various aspects of a collaborative decision-making process in a CMN. Further, new accounting principles such as value added costing and activity based costing are to be employed by all the members of CMN to share the profit and loss among the members in a proportionate manner, depending on the value added contribution. In order to establish a CMN among SMMEs, Nagalingam and de Fretes (2009) propose a collaborative partnership framework consisting in six stages as shown in Figure 1. The stages are depicted in a linear fashion but they are interrelated and can be repeated as needed throughout the process.

- Stage 1: Senior decision makers, based on their organisational capability, capacity, and product/services mix identify suitable and potential partner SMMEs, who can provide a competitive advantage to them. Establish relationships with partner SMME and explore collaboration, clarify purpose and boundaries of decision-making, analyse operational and performance information of members, identify environment and manufacturing parameters, and identify what resources currently exist to help the collaborative activity.
- Stage 2: This stage involves delegating authority to middle managers and developing strategies for CM in a trusting environment. It involves identifying any possible conflicts that may develop over time and establishing formal agreements to resolve; clarifying the objectives of the CMN across the functional boundaries of members; establishing knowledge domains to share and identifying the value activities across the CMN; and generating a formal statement for the decision-problem to be solved.
- Stage 3: Using appropriate tools and systems to analyse decision variables and parameters to reach a consensus decision across the CMN. In order to achieve this goal, legacy systems that exist among members of CMN may have to be replaced or reconstructed to facilitate information sharing and if necessary implementing interoperable systems for manufacturing and decision-making activities.



Collaborative partnership framework for SMMEs

- Stage 4: CMN teams across the member SMMEs get created and empowered to make appropriate decisions by gathering all the related and necessary information for reaching a common decision, evaluate the impacts of the decision, and delegate responsibility to a team member to succeed with this decision. Further, in this stage, the most expected scenario is to be defined based on the decision-problem statement, set of decision alternatives is considered and evaluated for consideration and a decision that will benefit the CMN as whole is to be accepted. This final decision is to be distributed to all members and to be accepted by the members.
- Stage 5: Verifying decisional boundaries for operations, integrating supply chain of the members of the CMN by using advanced ICT tools and systems, and establishing supporting mechanisms.
- Stage 6: Monitoring performance of the implemented system and identifying potential for further collaboration, evaluating the need for new collaborative partners, and consolidation of the activities of CMN.

This proposed framework, however, is not a complete representation of the complexities involved in forming collaborative partnerships yet. There are several factors such as dependency and independency, interrelations, control quality, how to exit that still need to be taken into consideration.

CONCLUSION

Forming a CMN by SMMEs, who have similar cultural fit and trust among participants, offers critically needed competitive advantage for this industry sector in the current economic market condition. By adopting this new manufacturing paradigm which emphasises the establishment of close relationships between participating manufacturing enterprises, SMMEs can benefit by making use of members' core competencies. Although CMN provides a pathway to develop key decision-making concepts, it is essential for open information integration architecture among members of a CMN for the implementation of this approach across business, project, and the team level. This ICT architecture must include factors such as independence, no hierarchy (equality of the partners), and fluid boundaries for successful collaboration. Enhanced connectivity and flexibility in manufacturing collaboration among members of a CMN to meet customers' demands in today's volatile market is viable by applying established distributed manufacturing concepts. Nevertheless, in order to use distributed manufacturing and CMN, all legacy systems of the collaborative partners must be integrated to create transparencies in data, information, and knowledge that are required to support the implementation of collaborative processes among the members of the CMN.

LIST OF REFERENCES

Berry, A(1997). SME Competitiveness: The Power of Networking and Subcontracting.

Bessant, J (1999). The rise and fall of 'Supernet': a case study of technology transfer policy for smaller firms, *Research Policy*, Volume 28, Pages 601-614.

Bilbao, N., Pozo, D. D., Lopez, J. M. and Etxaniz, I. (2004).The collaborative manufacturing approach.*2nd IEEE International Conference on Industrial Informatics.*

Browne, J, Zhang, J (1999).Extended and virtual enterprises—similarities and differences. International Journal of Agile Management Systems 1 (1), 30–36.

Chunquan, L and Dejian, Z (2006).*Study on small and medium enterprises collaborative manufacturing system based on agency organization services*.

Christopher, M (2005).*Logistics and supply chain management: creating value-added networks*, New York: FT Prentice Hall.

D'Amours, S, Montreuil, B, Lefrancois, P and Soumis, F (1999).'Networked manufacturing: The impact of information sharing', *International Journal Production Economics*, vol. 58, pp. 63-79.

Danilovic, M and Winroth, M (2005). 'A tentative framework for analyzing integration in collaborative manufacturing network settings: a case study', *Journal of Engineering Technology Management,* vol. 22, pp. 141-158.

Dyer, JH (2000).*Collaborative Advantage: Winning Through Extended Enterprise Supplier Networks*, Oxford University Press,

Dyer, JH, Kale, P and Singh, H (2001).How to make Strategic Alliances work. Sloan Management Review 42 (4):37-43.

Elmuti, D and Kathawala, Y (2001).'An overview of strategic alliances', *Managemenet Decision,* vol. 39, no. 3, pp. 205-217.

Fuller-Love, N and Thomas, E (2004).Networks in small manufacturing firms.*Journal of Small Business and Enterprise Development*, 11**,** 244-253.

Ghausi, N (2002). 'Trends in outsourced manufacturing – Reducing risk and maintaining flexibility when moving to an outsourced model', *Assembly Automation*, Vol. 22 Issue 1

Johansen, K, Comstock, M and Winroth, M (2005). Coordination in collaborative manufacturing mega-networks: A case study. *Journal of Engineering Technology Management,* 22**,** 226-244.

Kumar, K andVanDissel, H G (1996).*Sustainable collaboration: Managing conflict and cooperation in interorganizational systems.* MIS Quarterly: Management Information System. 20(3): p. 279-300

Lin, HW, Nagalingam, SV and Lin, G (2007).Towards Collaborative Manufacturing in Small and Medium Manufacturing Enterprises.*The 35th International MATDOR Conference.*National Taiwan University, Taipei, Taiwan: Springer-Verlag London.

Lin, HW (2008).Development of a Global Decision Support System towards Collaborative Manufacturing and Virtual Manufacturing.*Center of Advance Manufacturing Research.*Adelaide, University of South Australia.

Martin, C. (2002). Technology diffusion within small and medium enterprises in Australia: Repost on the effectiveness of dissemination methods. Milestone Report to the Department of Industry Tourism and Resources. Adelaide.

McClellan, M (2003).*Collaborative Manufacturing Using Real-Time Information to Support the Supply Chain*, Florida, CRC Press LLC.

Mayer, R, Davis, J and Schoorman F (1995). An Integrative Model of Organizational Trust, *Academy of Management Review* 20(3), 709–734.

Nagalingam, S.V. and de Fretes O.M.(2009).Integration of Small and Medium Manufacturing Enterprises through Collaborative Partnerships.*7th ANZAM Operations, Supply Chain and Services Management Symposium.*Adelaide, Australia, School of Management University of South Australia.

Overby, M. L (2005). Partner Selection Criteria in Strategic Alliances: When to Ally with Weak Partners. *DRUID*, Copenhagen Business School, Department of Industrial Economics and Strategy/Aalborg University.

Parung, J. and Bititci, US (2006).A conceptual metric for managing collaborative network.*Journal of Modelling in Management*, vol. 1**,** 116-136.

Sherer, SA (2003).Critical Success Factors for Manufacturing Networks as Perceived by Network Coordinators.*Journal of Small Business Management*, 41/3, 325-345.

Shi, Y. and Gregory, M (2005).Emergence of global manufacturing virtual networks and establishment of new manufacturing infrastructure for faster innovation and firm growth.*Production Planning and Control*, Vol. 16, No. 6**,** 621–631.

Winroth, M. and Danilovic, M. (2003).Linking Manufacturing Strategies to Design of Production Systems in Collaborative Manufacturing Networks.14th Annual Conference of the Production and Operations Management Society, POM-2003. Georgia, USA.

Zineldin, M and Bredenlow, T (2003). Strategic alliance: synergies and challenges: A case of strategic outsourcing relationship "SOUR". *International Journal of Physical Distribution and Logistics Management,* Vol. 33, pp. 449 – 464