Taxonomy of Electronic Manufacturing Service (EMS) providers’ supply capabilities

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Abstract

An in-depth understanding of Electronic Manufacturing Service providers is yet achieved due to their dynamically changing positions on the value chain. This article aims to provide taxonomy of these external suppliers in terms of their roles and business models along the collaborative supply chain. Based on preliminary case study over businesses in two of the world top five EMS, the article summarizes three EMS supply patterns, which are consigned pattern, vertical integrated pattern and horizontal integrated pattern.

1. Introduction

Electronic Manufacturing Service (EMS) as the emerging industry has developed rapidly over the recent decade. The industry is important not only because of its growing market size (projected to be over $200 billions in 2006 by iSuppli), but also the dynamics it brings in the supply network of the electronic manufacturing industry.

Since the 1970s, a new type of service has emerged in the Silicon Valley and other areas, which provided through-hole assembly of the PCB board for Original Equipment Manufacturers (OEM), mainly to even out peaks in demand. With the market surging in the 1990s, especially in telecommunication and computer segments, EMS providers experienced the biggest-ever prosperity. Leading companies such as Celestica, Solectron, SCI etc reported an annual revenue growth rate of over 10%. They evolved into a group of players in their own right, referred to as EMS rather than formerly Contract Electronic Manufacturers (CEM). In the 21st century, EMS industry witnessed the bust from 2001 through to 2003, due to the saturation of telecommunication market. The tighter control of OEM over the supply chain results in thinner profit margin for EMS providers. They started to seek higher value-added services such as module or product design. As a result, Taiwanese Original Design Manufacturers (ODM) suppliers come under the spotlight. It is widely recognized that their business model has been indistinguishable from that of EMS. Looking back through their migration path, it is clear that EMS/ODM suppliers have become the most proactive actors in the supply network. The diversified business models, combined with EMS extremely global dispersed operation, impact on the structure of supply network dramatically.

Moreover, in reverse, the changing supply network structures help EMS companies to achieve organic growth or purposely reshape their business model, create more value along the value chain, and even adjust their strategic positions in the whole industrial network. We feel it is important to gain the thorough understanding of the EMS/ODM suppliers’ business model dynamics, which may be laying the groundwork for OEM’s supply chain structure design and practically helps to integrate their supply chain and improve the buyer-supplier relationship.

2. Literature review

Research related to EMS or Contract Electronic Manufacturing (CEM) in its own right has emerged only in the recent years. There are two major trends taking different unit of analysis.
The first is from the intra-firm perspective, taking EMS companies as the unit of analysis. At strategic level, Hunt and Jones (1998) adopt the relationship perspective and assert that a CEM company should provide advantages such as competitive pricing, materials management, faster product take on, technology development, effective communications and business opportunities to win business from OEMs. Later, much work has shed lights on the competitiveness of EMS companies in different geographies such as Li (2005) on UK EMS industries and Guzman (2003) on developing nations such as Brazil. As EMS industry boomed over past decades, enterprises from Mainland China and Taiwan quickly grows into world giants, their mode of development arouses academic interests. Zhai (2006) contends that for an EMS company to obtain firm growth, dynamic capabilities should be acquired by four steps of penetration, accumulation, evolution and adaptation. At the operational level, the supply complexity for EMS providers stays projected. With the shortening product life cycle and the pressure to speed up New Product Introduction (NPI), more electronic manufacturing companies have turned to contract manufacturing to reduce the risk of increasing expense of manufacturing and inventory management. CEM providers’ fluctuation of supply forecast has been dampened as they count on the large product mix realized by servicing multiple customers and dedicated manufacturing. Tardif (2001) analyses the phenomenon and clarifies the understanding of the CEM supply forecast variability. She proposes that forecasts do not get more accurate as the production period nears, but begin to vary more widely. Also poor management of the backlog, resulting for unmet demand, results in unattainable production targets and even more variations. Besides, profiles of EMS are also provided such as Luthje’s work in 2003.

The second trend explores the attributes of a production/supply network with EMS providers as the key actors. Research on the industry chain is the economic concentration by OEMs and EMS business, which reinforces their capacity to innovate, increase sales and improve quality and productivity. Sturgeon (2002) introduces the modular production network as a new conceptual industrial organization model that yields better economic performance in the context of globalization. His latest work (2004) also elaborates a new model of industry co-evolution based on the comparison between American and Taiwan electronics contract manufacturers. From OEMs’ point of view, research has emphasized much on outsourcing strategy (Probert 1997; Kim 2002) or buyer-supplier relationship development (Lamming 1993; Bensaon 1999; Quinn 1999). The work from the supply network perspective, however, is still insufficient. The latest work by Mason and Cole (2002) is one of the few and examines the ways in which contract manufacturing has increased the agility of the electronics manufacturing supply chain. However, with the rapid and dynamic changes since the revival of EMS industry in 2004, EMS companies have sought various business models that reconfigure the supply network. In this paper, we aim to propose a more comprehensive understanding on the EMS business model in the latest practical context. It can be further employed into a supply network design in the next stage of research.

3. Case presentation

Company A:

**Background:** Company A is one of the world top 5 EMS companies with annual revenue of over $10 billions. It has expanded in around 90 cities of 30 countries. As
its business increased in Mainland China, it established presence in a suburb town of City Z in Guangdong Province. We chose their biggest site in Mainland China for close investigation. It has incorporated abundant products and comprehensive manufacturing capabilities.

The political and geographical advantages stimulate Company A’s development. City Z is one of the 5 national Special Economic Zones (SEZ). Their municipal modernization started as early as in 1980 when China first conducted the reform and open policy. Though nowadays the privilege of direct investment in SEZ is less projected, they still benefit from Central Government’s favourable policies on taxation, land disposal, project approval procedures etc.

City Z is located in the southern most part of mainland China. Hong Kong is only 70 minutes away by ship. There is an airport in City Z outskirt area. Transportation convenience greatly facilitates their logistic activities.

The whole site was set up from green-field in the mid 1990s. As the biggest FDI in the city, Company A has been greeted with a ‘green light’. It is granted with relatively higher autonomy to the usage of the land. The company builds roads, staff accommodation, dining hall, electricity supply infrastructure of its own. It is continually enlarging the area to fully accommodate its own factories and even those of their suppliers.

Up till now, it has employed over 20,000 people in one single site. Their large capacity enables them to meet high volume demand from a very diverse customer base, domestic as well as international. Main products or modules include mobile handsets, computers and peripherals, printers, consumer electronic goods etc. Company A centering on these products and modules, has developed diverse businesses for value creation. Among which, we select several products or modules and present them in the sub-sections as follows.

**Production business with mobile manufacturing for OEM A:**

Company A has been with OEM A, one of the first-tier mobile manufacturers in the world, for a long term of contract since the year of 2003. Company A’s site in City Z is carrying out a significant portion of OEM A’s mobile handset manufacturing. The volume of each batch can range from low, medium to high, depending on the product life cycle stage. The total daily output of one specific product line reaches to over 15,000 units. Due to the large capacity, Company A is devoted in one specific product line for OEM A’s order with 8 to 10 single-sided lines. Company A sets up a specific supporting team dedicated to OEM A, including engineers, operation administrators, customer relationship assistant and material purchasers and planners.

**Key processes:**

In terms of manufacturing, a mobile handset is comprised of flip PCB board and main PCB board. A general set of processes to produce a mobile handset in Company A is divided into steps of PCB assembly, module assembly and fully system assembly, as illustrated in Figure 1.
Company A has in-house capabilities of PCB fabrication, PCB assembly, LCD module assembly in the clean room, front and back housing fabrication and final assembly. We focus on PCB/module/fully system assembly in this sub-section. The others will be covered in the following ones.

Elements on supply chain:

Production service is one of the major deliveries to OEM A. During the research, we found that the ambiguity exists in the EMS ‘production service’ notion. The original functional perspective usually causes misunderstanding in the business boundary. Therefore, we suggest a two-dimensional way of describing the production service based on the material transformation as in the vertical dimension, and the product life cycle (PLC) sequence as in the horizontal dimension, depicted in the Figure 2 as follows.

Figure 1: Mobile handset assembly processes

Figure 2: Production Service Scope
Clearly from the diagram, this business occupies the single production section on the supply chain. However, the range of the service along the horizontal and vertical dimensions may vary from company to company. In Company A, the full range of production service along both dimensions is provided, known as ‘one-stop solution’ package.

Cross-organizational supply chain structure:

Unlike other OEMs which prefer to utilize the advantage of EMS providers’ mass procurement, OEM A obtains the control over component suppliers. Therefore the structure of its supply chain is displayed as in Figure 3:

Figure 3: Supply chain structure with OEM A

**Mechanical service: CDM business and mechanical fabrication**

Company A provides mechanical design and fabrication service to customers. OEM A is one of its largest clients seeking mechanical service.

Mechanical fabrication service in Company A includes tooling fabrication, plastic injection molding, metal stamping and plastic printing. There are enough molding and stamping capacity with different range of presses. Printing with automatic robotic arms and high-speed spindles is available. However, the capacity has not been fully utilized. Its current customers are the major accounts making PC and mobile handsets.

The design for mechanical parts is named Contract Design Manufacturing (CDM) service. Originally the tooling fabrication and design was in Southeast Asia sites. After OEMs began to use mechanical service in the City Z site, the logistics overhead between design and fabrication prompted them to seek local design service. Therefore, on demand of customers, the City Z site established its mechanical design team from
2004. At present, the group is dedicated to OEM A’s mobile handset. With little previous experience in mobile handset design, CDM group works with engineers from OEM A and Company A of Southeast Asia sites in the beginning. But it picks up quite fast. Now it develops a new model with averagely 7 to 8 months.

Key processes:

The mechanical components are fabricated in an independent factory building 1km away from the assembly factory. It plays the role of an internal supplier, integrated to a certain extent. They receive demand forecast from assembly group. Finished goods are kept with low inventory in the central warehouse within the site.

Mechanical design is an interactive process with customers and manufacturing teams. Its process is displayed in the following Figure 4:

Figure 4: CDM service process
Elements on supply chain:

The CDM service obviously occupies the forward part of supply chain. We take a two dimensional perspective to clarify the boundary of the service. Similarly, the horizontal axis is design and development processes and the vertical one is material forms. As shown in the Figure 4, the design for mechanical parts is initiated by customers. Company A’s entry point is just the step before prototyping. Hence a rather narrow scope of CDM service is presented in Figure 5.

![Figure 5: CDM service with OEM A](image)

Cross-organizational supply chain structure:

![Figure 6: Supply chain structure of mechanical business](image)
Figure 6 shows the material flow and information flow between EMS providers, suppliers, OEMs and end customers. EMS companies possess the control over the supply of rather uniform materials such as metal sheets and plastic particles.

**ODM module system**

ODM service means the offer of a module or a product to customer from the original design to the finished goods. ODM distinguishes from CDM in that ODM initiates the concept of the module or product, although relies on the OEM’s approval during the design and development process, while CDM works on limited design and development task according to OEM’s contract.

In the late 2003, Company A set up its ODM service presence in City Z site. In its US headquarter, the early phases of ODM are carried out. Then the whole design will be transferred to City Z in China after the development stage starts. With the substantial investment on technology and the sufficient capacity for high volume, the ODM team in City Z successfully met the target of 6 million units of modules per month. Their modules are widely used by OEMs producing mobile handsets.

**Key processes:**

A typical module in ODM service requires the processes of Design, Development and Production to be delivered to customers. There is still finer division in each step. Figure 7 shows how a new module is introduced to OEMs.

**Figure 7: ODM processes**

Elements on supply chain:

ODM service occupies the design and production sections along the supply chain. Figure 8 illustrates the wide range of ODM service scope.
Cross-organizational supply chain structure:

ODM service enables EMS providers to gain the bargaining power over supply chain. Company A can select its own suppliers without comply with customers’ supplier selection criteria. To be qualified, Company A’s suppliers should adopt SMI (Supplier Management Inventory), in which the suppliers need to own and manage the inventory of finished goods before EMS send out a demand signal. Figure 9 shows the supply chain structure.

![Figure 8: ODM service scope](image)

![Figure 9: Supply chain structure of ODM business](image)
**Company B**
Established in Taiwan in 1970s, Company B has become the world top EMS provider with annual turnover over $15 billions. Now it has expanded aggressively with a truly global presence. Its CEO summarized its development path as the CMMS mode – Component, Module, Move and Service.

The first stage ‘Component’ has been reached in 1980s, when Company B was known as the top-ranked provider of cables and connectors for PC. Their rapid development relies on their efficient cost reduction and products’ variability and reliability. By the year of 1991, Company B has controlled the largest market share of connectors and cables in Taiwan. It is one of the major connector suppliers for quite a few world top PC manufacturers, including Acer, HP, Apple, as well as telecommunication giants such as Motorola and Nokia. One of the remarkable capabilities developed during ‘Component’ stage is tooling. It has been proved to be more than necessary in sustaining diversified components development, as that of enclosures. Now it’s the biggest enclosure supplier for Apple.

The second ‘Module’ stage summarizes its major move in the 1990s. It was a period when Company B focused on component integration. What is crucial in this stage has surpassed ‘assembly-only’ notion and highlights on engineering capabilities, such as design for assembly, design for manufacturability etc. The ‘Move’ stage is an extension of ‘Module’, during which, Company B started to provide fully system/box assembly. Up till now, it has become the truly ‘one-stop solution’ provider.

The last move ‘Service’ aims to be fully involved in the early product life cycle process. It mainly refers to the service of joint design at the product level. With a R&D center established in Houston, Company B takes a full advantage of the proximity to customers. Now it has also been known as providing quality ODM service.

Looking through the overall development, Company B has become more than a traditional contract manufacturing service provider – not only with assembly activities but with the specialty on higher value-added businesses down or up the supply chain. In the 1990s, Company B established its largest factory in City S in Pearl Delta River region, with employees over 100,000 in 2004.

4. **Theoretical contribution/breakthrough**
Based on the case study, there are three value proposition patterns that EMS providers apply.

**The first level is Consigned pattern.** Its main characteristic is that EMS providers occupy limited scope along the value chain. Figure 3 shows that they possess almost non control over either upstream or downstream supply chain partners. EMS providers assume consigned assembly tasks from OEM, ranging from PCB assembly, subsystem / module assembly to full system / box assembly.

A finer classification of the consigned pattern is technology intensive and labor intensive sub-patterns. Technology intensive sub-pattern means engagement in engineering complexity and implementation of automated and precision technology. For labour intensive sub-pattern, manual assembly is the major activity. Managerial
Methodologies and sophisticated layout is usually applied to improve efficiency of the material flow.

The observation of Consigned-patterned EMS shows that labor intensive sub-pattern such as manual module or full box assembly may not be a common service among SME (Small and Medium Enterprise) EMS providers, where high expenditure on manual labours prevents from a reasonable profit rate that sustains their survival.

Although the Product life cycle span in consigned pattern is fairly wide, as shown in Figure 2, the added value is limited. Work has been specified and assembly procedures are designed or approved by customers. OEMs retain control power over EMS’s first tier direct material suppliers, assigning component providers, equipment suppliers etc. to EMS companies.

The second level is Vertical Integrated (VI) pattern. The mechanical fabrication example shown in section 3 is a typical move of EMS towards VI pattern. Typical components include enclosures, PCB, connectors and even software for telecommunication device. Manufacturing capabilities and its specialty in the specific component become the EMS’ competitive advantage. Also EMS may act as an across-tier supplier as in supplying its own equipment providers. Because of the capability advantage, this VI pattern features with EMS’ dynamic position in the supply network. However, the limitation in supplier selection is still inevitable. But the internal supply enlarges the profit margin. In this pattern, EMS plays the role of ‘one-stop solution’ provider along the supply chain.

The third level is Horizontal Integrated (HI) pattern. EMS on this level develops all-around capabilities around one product. It offers a wide span of services ranging from product design, tooling and mechanical design to testing and analysis tools development to logistics service etc. ODM package demonstrates an extreme of HI pattern. Innovation capabilities win them competitive advantage. There is stronger control power on upstream suppliers in EMS. They play the role of supply chain coordinator, organizer and sometimes initiator among the players.

5. Conclusions

A few key points in understanding the taxonomy:

- There is no absolute ‘lower’ or ‘higher’ level among the above three patterns. It should not be asserted that EMS in Consigned pattern is less matured or capable than that in HI pattern. In the current stage, EMS cannot discard any of them to pursue higher added-value.
- There is no clear connection between the pattern selection with the stage of product life cycle. From our research, it may not be true that value can be generated by early involvement of PLC. It is only so when the involvement is comprised of early stage of design and development or is secured by the succeeding volume production, where the largest portion of value comes from.
- There is a certain correlation between the above patterns and the cross-organizational supply chain relationship and structure. The higher the value added in a certain pattern, the more bargaining power the EMS providers possess in the supply chain, and the more likely OEMs reduces its direct supplier base and dependent on EMS.
References:


