

# **Tackle the changes in Mobile Handset Industry: outsourcing arrangements and the corresponding management methods**

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## **Abstract**

Over the past decade, mobile handset industry has witnessed its booming, as well as the most significant transformation. Players have increasingly outsourced a wide spectrum of design and manufacturing activities to contract manufacturing service (CMS) providers. However, CMS, a unique type of suppliers, proactively and constantly re-structures the manufacturing value chain. The way a mobile-handset vendor manages its CMS has become the critical factor that differentiates the success from the failure. This paper aims to address the dynamics of the outsourcing arrangements and the corresponding relationship management methods between the mobile handset vendors and CMS. Through the in-depth study of five types of mobile handset models, it identifies three types of outsourcing arrangements, which are Manufacturing Task Outsourcing, Package Outsourcing, and Full Outsourcing. The research also indicates that Integral, Medium, and Modular Collaborative Relationship Management methods are likely to be applied in the contexts of the three outsourcing contexts respectively.

## **Key Words**

Outsourcing, Contract Manufacturing, Relationship Management

## **1. Introduction**

Over the past decade, mobile handset industry has experienced the strongest growth, as well as the most significant transformation. Till 2008, the market size has expanded to four times of that in 2001 (Strategy Analytics 2009). Meanwhile, the competition has become ever more intensive. This industry is undergoing the deepened customization that demands for high flexibility in design and production, with the faster clockspeed than any other electronics sector (Comstock et al. 2004).

To cope with the challenges, the mobile handset vendors increasingly rely on outsourcing to gain/maintain competence. Research shows that contract manufacturers produced over a third of mobile phones in 2007 (iSuppli 2008) and it is believed that outsourcing of mobile handset manufacture will remain a growing industry trend in the forthcoming years (VisionGain 2006).

For nowadays mobile-handset brands, whether or not to outsource is not the critical decision. The management of outsourced design and manufacturing has become a paramount factor determining competitiveness. As pointed out by iSuppli analysis, 'the way a mobile-handset brand uses design houses and contract manufacturing can make the difference between success and failure in the market' (iSuppli 2008).

During the field work, practitioners addressed a number of management issues at operational level during the production/design outsourcing. Some typical difficulties may involve:

- Lack of fundamental manufacturing data to control the production processes and quality
- Choice over EMS/ODM's varying manufacturing and design capabilities

- Scheduling production with external manufacturing facilities
- Redesign of the material/information flow route
- Crack the barriers of organizational boundaries in production's fast responsiveness to design change

It can be noticed that with the vertical disintegration of the industrial value chain, the decentralized and fragmented forms of material/information control have compelled the companies to be confronted with serious challenges in managing an efficient supply chain that once performed production and design internally. There is clearly a lack of knowledge with operations management in such outsourcing contexts. Without the guide of which, the operational objectives of cost down, flexibility, delivery, time-to-market can not be achieved satisfactorily.

In theory, outsourcing is not a new phenomenon where it has been viewed and studied as the strategy associated with 'core competence', 'make-or-buy', 'strategic sourcing' etc. (e.g. Conner and Prahalad 1996, Alexander and Young 1996, Probert 1997, Quinn 1999, McIvor 2000, Williamson 2008). It makes more emphasis on strategic decision-making, rather than on the operational implementation.

Traditionally supply chain relationship research strives to understand the relationship natures (e.g. Macaulay 1963, Williamson 1975, Ford 1978, McCarthy 1978, Dore 1987, Sako 1992, Lamming 1993 etc.) and specific issues between buyer and suppliers, such as supplier involvement, supply chain integration, collaborative planning, information sharing, strategic purchasing etc. (e.g. Bensaou 1999, Frohlich and Westbrook 2001, Lee 2000, Christopher 2005, Grover and Saeed 2007 etc.). However, as noted by a number of researchers over the phenomenon of contract manufacturing/designing, the key suppliers, i.e. EMS (Electronic Manufacturing Service Providers) and ODM (Original Design Manufacturers) have transformed the structure and relationships in the supply/production network (Da Villa 1996, Sturgeon 2002, Luthje 2002, Guzman 2003, Shi 2005). Therefore these players are distinct from traditional commodity suppliers. They proactively accumulate capabilities and migrate towards the upstream and downstream value chain (Li and Shi 2005, Zhai 2007). The dyadic supply chain management theories seem inadequate to reflect the unique demands in managing the relationships between OEM and contract manufacturers at the operational level.

Furthermore, much outsourcing and supply chain relationship management literature has long been focusing on automobile industry (e.g. Collins et al. 1997, Lamming 1993, Sako 2003, etc.). However, mobile handset industry, characterized with more modular product architectures, shorter product life cycles, and greater extent of customization, is less investigated (Sturgeon 2002, Comstock et al. 2004, Marshall et al. 2007).

This highlights a clear need for a comprehensive understanding of the contract manufacturing/design in the mobile handset industry and the corresponding relationship management method in this context.

This paper will proceed with the following structure. The second section reviews literatures pertaining the research (sub-)questions. It clarifies the research gaps and provides a preliminary framework. The third section justifies the research methodology adopted to address the research objectives. The fourth section describes and analyses five in-depth cases in three companies. The fifth section provides the key findings and the final framework.

Finally, the research is concluded and the implications/limitations for practice and theories are discussed.

## **2. Literature Review and Preliminary Framework**

Contract Manufacturing is a unique type of outsourcing. Research bodies on outsourcing in general lay the theoretical foundation. To explore the relationship management between OEM and CMS, the works on the relationship natures, dyadic supply chain relationship, outsourcing relationship management etc. are reviewed. They provide a preliminary framework on the contract manufacturing relationship management elements.

### **2.1 Outsourcing and Contract Manufacturing**

The concept of outsourcing has not been officially introduced and systematically explored until the mid 1990s when it was regarded as a strategic approach to increase competitiveness (Quinn 1994, Alexander and Young 1996, Jennings 1997).

Focusing on determining the firm boundaries, the outsourcing research has become the synonyms of make-or-buy decisions, referring to the problem that whether a part or a process should be purchased from outside supplier or performed internally (Dale and Cunningham 1984).

However, with the outsourcing practice developing into a more complex form, the outsourcing concept has been evolved into a much more extensive view. It should not be simplified as the transitional decision-making process where a firm decides whether an activity traditionally in-house should or should not be contracted out with an external entity (Varadarajan 2008).

Therefore, outsourcing should be regarded as an integrated process that incorporates both strategic and operational decisions preceding the supply chain management procedures. Thus outsourcing arrangement and supply chain management should be aligned to achieve optimized performance (McIvor 2005).

To provide a holistic insight into 'what after make-or-buy', there emerged theories, as well as practical guides, investigating outsourcing processes (McIvor 2000, 2003, 2005, Strauss and Geimer 2001, Momme and Hvolby 2002). They extended the previous work which focused on the process of 'make-or-buy' decision only.

In McIvor (2000, 2003)'s framework, there are four stages in outsourcing as follows: define the 'core' activities of the business, evaluate relevant value chain activities, total cost analysis of 'core' activities, and relationship analysis. Wasner (1999) argued that the process of carrying out the transfer of an activity from being internally controlled to becoming externally managed is equally difficult because of interdependencies at the operational level. This research perceives the 'outsourcing' as an integrated process which is divided into four stages. Each stage incorporates a range of research bodies, as shown in Figure 1:

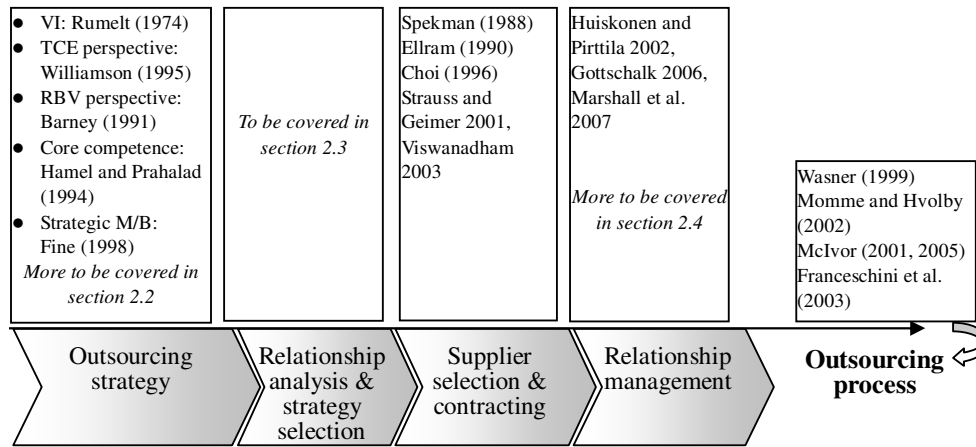


Figure 1: Outsourcing process and related research bodies

Contract Manufacturing has not been deemed as a strategic way to extend the outsourcer’s capability until the mid 1990s (Conklin and Perdue 1994). Researchers have noticed distinctions between contract manufacturing and outsourcing (Chan and Chung 2002). With the dynamics of the CMS capability evolution (Zhai 2007), the typology of this special outsourcing strategy has yet been fully understood. Sturgeon (1998) and Kim (2003) divide the CMS from purchasing perspective into part consignment and turnkey arrangement. Considering the variety of the outsourcing tasks and the upgrade of the CMS capabilities, more types of CMS are discussed by Luthje (2001). He illustrates five types of OEM-CMS integration model in Table 1.

Table 1: Different models of OEM and CMS integration

| OEM business model  | CMS business model  |
|---|---|
| Fables company—minimal .nal assembly and testing (Cisco, Sun . . .)                               | Full-scale manufacturing and supply chain-management (engineering—logistics)              |
| Full-scale outsourcing of product lines and/or plants (IBM, TI, Siemens ICM . . .)                | Full-scale manufacturing and supply chain-management—plant conversion                     |
| Large-scale .nal assemblers with high volume outsourcing of key components (Dell, Compaq, HP CSD) | Mass production of key components (dedicated lines)                                       |
| Customized final assembly in key markets (Compaq, Dell, HP PCD in Europe and Asia)                | Final assembly (box-build) (includes local CM partners)                                   |
| Still open: vertically integrated OEM from Japan and Korea  | For example, Sony/Soletron, Acer/Soletron, Mitsubishi/Soletron, Sony-Ericsson/Flextronics |

Sanders et al. (2007) uses two dimensions to classify outsourcing arrangements. One is the same as McIvor’s ‘activity criticality’. The other is the scope of outsourced activities. There are four categories of outsourcing arrangements divided by ‘scope’: out-tasking, co-managed services, managed services, and full outsourcing (Sanders et al. 2007).

Bengtsson and Berggren (2004, 2008) discover two different routes, horizontally integrated model and vertically divided model, to disintegrate manufacturing in Nokia and Ericsson. The two contrasting outsourcing models are divided based on a product life cycle perspective. In the first model, OEM and its suppliers are each responsible for selected modules during the entire product life; in the second one, OEM takes care of development of strategic modules and systems while EMS is in charge of all volume production across nearly all modules and systems.

However, all the above typologies for contract manufacturing, except for Bengtsson and Berggren (2004), seem too aggregated to reflect the outsourcing scope for one specific

product. Bengtsson and Berggren (2004) provide a very useful new angle to classify outsourcing based on product life cycle stages. Nevertheless, they analyze the outsourcing modes based on three PLC stages only, which seems less comprehensive to address numerous outsourcing implementation issues. In addition, the models take into account only one type of product, i.e. radio base station, without discriminating product lines that require for different outsourcing arrangements. The data it collected from telecommunication equipment industry date back to the early 2000, which may not be applicable to nowadays mobile handset industry. Therefore, the first gap identified is the typology of contract manufacturing from product perspective, based on a more comprehensive understanding of the product life cycle stages and a more diversified set of product requirements.

The emergence and upgrade of the CMS causes the changes to companies' product development process, manufacturing strategy, control of the manufacturing process etc., and also impacts the performance of the supply network (Mason et al 2002). Sturgeon (2002) contends a new form of network, called modular production network, as a direct result of the OEM's outsourcing manufacturing from CMS. However, the management of the decisive links of this network between OEM and CMS remain open. The relevant research on managing the OEM and CMS relationship will be discussed in the following sections.

## **2.2 Relationship nature between OEM and CMS**

Definition of relationships in the business environment has been widely acknowledged as the whole system of conducting interaction and exchange between buyers and suppliers (e.g. Macaulay 1963, Williamson 1975, Ford 1978, McCarthy 1978, Dore 1987, Sako 1992 etc.). In fact, managing the supply relationship has been proposed as the equivalent with the supply chain management (Harland 1996).

There have been various types of relationships between buyers and sellers. The nature of OEM and CMS relationships has been evolved over the decades. Langfield-Smith (2003) believed that outsourcing relationship is covered by a broad range of strategic alliances. McIvor (2005) presented four types of relationships during outsourcing, i.e. competitive collaborative, close collaborative, adversarial, and secure supply, which are suitable for different internal (activity criticality) and external (supply market risk) situations. In his following work, McIvor (2009) further discusses the outsourcing relationship strategies in different external environments (categorized by a variable called opportunism). The corresponding relationships are known as non-specific contracting, recurrent contracting and relationship contracting.

More specifically on the OEM and CMS relationships, Conklin & Perdue (1994) pointed out that the type of relationships required in contract manufacturing is strategic alliances. Such alliances with CMS can take many forms, including production joint ventures, technology transfers, manufacturing agreements, equity positions and consortia. 'They can even expand beyond the production aspects to include horizontal collaboration across related business capabilities' (Conklin and Perdue 1994). The description explicitly addresses the strategic criticality of the OEM-CMS relationships and the dynamic roles of CMS during its evolution. The following decade saw conventional outsourcing on a transactional basis moving toward more collaborative outsourcing arrangements (Delattre et al. 2003).

More specifically, Herrigel and Wittke (2006) study the varieties of vertical disintegration and notice the existence of so-called 'sustained contingent collaboration' between OEM and its outsourcees. It shows that suppliers can have a range of relationships with different customers and with the same customers across different contracts.

The above review shows that part of the research on 'managing contract manufacturing' lies in the area of 'collaborative relationship management'. The aspects of the contract manufacturing relationship research are clearly too limited. No specific research exists to address a more comprehensive range of management elements in the ever complicated outsourcing relationships between OEM and EMS/ODM. This makes the second research gap.

In this research we make a focus on relationship management from operations perspective specifically for contract manufacturing. Elements associated with social and behavioral studies will not be covered.

### **2.3 Relevant research on relationship management**

Multiple research streams are involved with the investigation on how to manage the relationships. One major stream is dyadic supply chain management which incorporates topics such as supply base rationalization, long-term relationships, supply chain integration, early supplier involvement, lean supply etc. As the research into buyer-supplier relationships in general, Bensaou (1999) identified four types of relations, i.e. captive supplier, captive buyer, market exchange, and strategic partnerships. The three dimensions of the relationships are: information-sharing practices, characteristics of boundary spanners' jobs, and the social climate.

Long-term relationship, regarded as having a positive impact on supplier performance, looks how to maintain relationship in a long period of time which is more strategic (Carr and Pearson 1999, De Toni and Nassimbeni 1999). Supply base rationalization has a clear impact over supply chain performance such as inventory management and logistics cost reduction (Trevelen 1987, Bozarth et al. 1998), increased economies of scale (Hahn et al. 1986), improved buyer-supplier product design relationship (De Toni and Nassimbeni 1999) etc.

The tactics for supply chain integration are frequently discussed under the name of process reengineering literature (Hammer and Champy 1993, Hammer 1996, Burgess 1998), JIT supply management (Chen and Chen 1997, Tan et al. 1998, Narasimhan and Carter 1998, Chapman and Carter 1990), product postponement and mass customization (Lee 1998, Van Hoek et al. 1998, Pagh and Cooper 1998), TPL (Saunders 1997, Gattorna 1998, Marvick and White 1998), or information technology and system integration such as EDI, information sharing (Bowersox and Daugherty 1995, Hart and Saunders 1998, Hausman and Stock 2003, Grover and Saeed 2007).

Lamming (1993) examines the relationships concept in the automotive industry, where he proposes lean supply implying the minimum wastage, lead times and minimum reasonable inventory. He suggests that relationship factors be introduced to be used as a framework for analyzing relationships (Lamming 1993). The factors include the nature of competition in the supply market, sourcing decision basis, information management approach, joint capacity planning, delivery practice, price change management, product quality management, R&D management, level of pressure in the relationships.

Compared to dyadic supply chain management, outsourcing relationship management theories provide more specific focus on functional outsourcing. Amaral et al. (2004) discusses OEM's control over CMS when outsourcing procurement activities. The six procurement outsourcing approaches identified include turnkey, turnkey with audits, supplier rebates, buy-sell, consignment, and in-house. Webster and Alder (1997) are among the few researchers concentrating on the operational issues associated with subcontracting in manufacturing

sector. The issues they raise include choice of subcontractor, control over manufacturing activity, scheduling of work, and material control. Da Villa et al. (1996) discriminate the different types of relations and examine 14 diverse characteristics of the relationships which act as the discriminator in defining the relations. They are subject, focus, stability, exclusivity, subcontractor location, lot size, technical assistance, information exchange, type of contract, type of subcontractor, routings, subcontractor's involvement in product industrialization, control, and subcontractor size.

### 2.4 Research gaps identification and preliminary frame work

Based on the outsourcing process identified in Figure 1, the research bodies corresponding to each outsourcing sub-process can be classified into firm centric and function/process centric categories. The discussion in section 2.1 shows that the first gap remains in the typology of contract manufacturing arrangements. As suggested in section 2.3, the exploration on the relationship management with CMS can be inspired by theories in dyadic supply chain relationship management and outsourcing relationship management, while they may not sufficient to address a holistic view on the relationship management constructs from operational perspective.

Outsourcing has long been explored without linking the strategic arrangements with supply chain management during implementation stage. This research also seeks to link the different types of contract manufacturing scopes with the relationship management. Its theoretical position is illustrated in Figure 2.

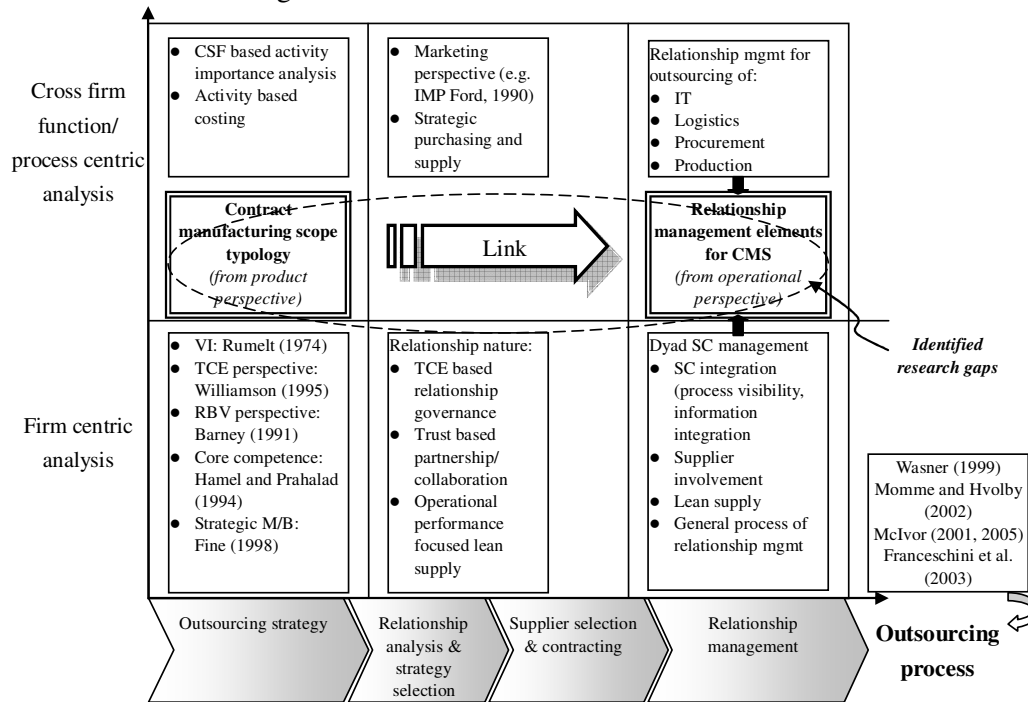


Figure 2: Theoretical position of this research

A preliminary framework is summarized as in Figure 3.

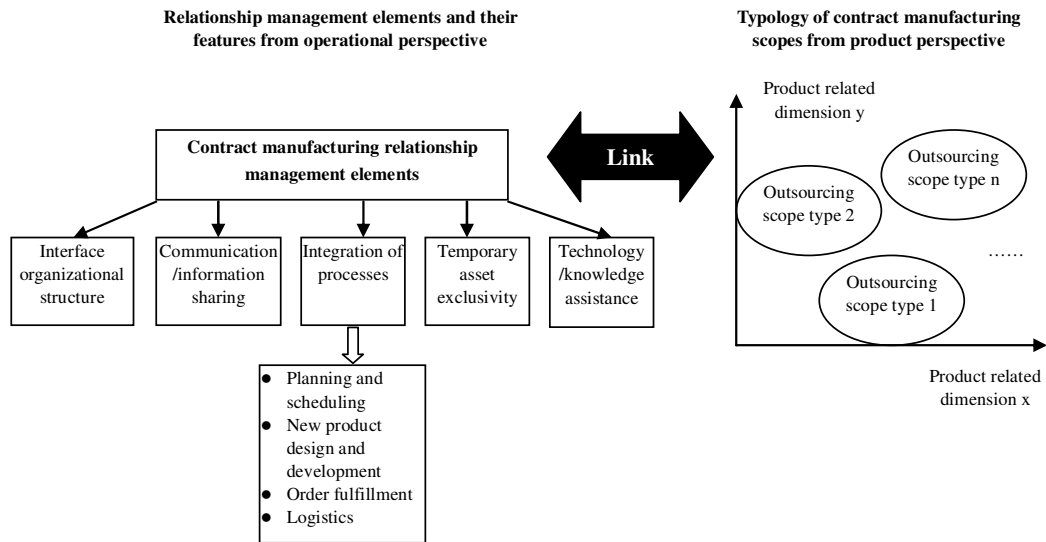


Figure 3: Preliminary framework based on literature review

### 3. Research Methodology

With the identified gaps, the research inquiries are refined as follows:

***How OEM-CMS relationship is managed in alignment with the different outsourcing arrangements at operational level?***

It is constructed by the following set of sub-questions:

**Sub-question 1:** From the product perspective, what are the outsourcing scope categories in contract manufacturing?

**Sub-question 2:** What management elements should be incorporated in managing the relationships between OEM and CMS at operational level?

**Sub-question 3:** What are the features of these elements when different outsourcing scopes are implemented?

As suggested by Yin (2003), it is most proper to select case study as the main method of research to answer a ‘how’ question. A case study protocol needs to be developed to craft the instrument especially in multiple case studies. It has something in common with questionnaire in survey where both direct the data collection at a single data point. However, it is more than just a guide for what type of data is to be collected. Eisenhardt (1989) discusses multiple data collection methods and multiple investigators as the tactic to ensure the quality of research. Yin (2003) notes that a protocol should contain the instrument as well as procedures and general rules.

Considering the nature of the research, the researcher addresses the following structure of protocol, including the major steps of preparation, fieldwork procedures, work afterwards.

- *Preparation:* a package for field work preparation is generated, including a project brief and an outline of interview questions to access the companies. The forms may vary

according to different company's requirements and cover a slightly wider range of topics to allow flexibility and attract more active participation from practitioners. A detailed questionnaire is also prepared before fieldwork. Short telephone conversations are made with the contacts when possible to communicate the intentions of visits and to guarantee that interviews are properly arranged.

- *Fieldwork procedures:* The researcher paid site visits to dozens of OEM and CMS companies for theory building and testing, including those listed in Table 3-5. While on site, the collected data include several 'modules':
  - Product architectures and development/production processes: the researcher follows the mobile phone models or a few types of handsets that share the same outsourcing arrangements in OEM companies. Product basic information is collected such as features, sales channels, volume of production, demand variety, rough BOM cost etc. Then general product architecture is questioned. The stages of product life cycle are inquired especially for the development and production processes. This 'data module' is to form the foundation to understand the typology of outsourcing arrangements
  - The key tasks to be fulfilled in OEM and CMS: centering on the product models being selected, the major tasks over the full handset or the subassemblies are either assigned to CMS/key suppliers or kept internally. The data are gathered regarding what tasks being conducted in OEM/CMS and how they are fulfilled.
  - The main interactive activities and operational issues at the interface of OEM/CMS: during the contract implementation period, there are multiple processes that are carried out across the OEM and CMS organizational boundary, such as material management, new product design and production, logistics etc. The interviews put emphasis on understanding this interaction and the management issues that may incur.

The structure of the above 'data modules' is illustrated in Figure 4.

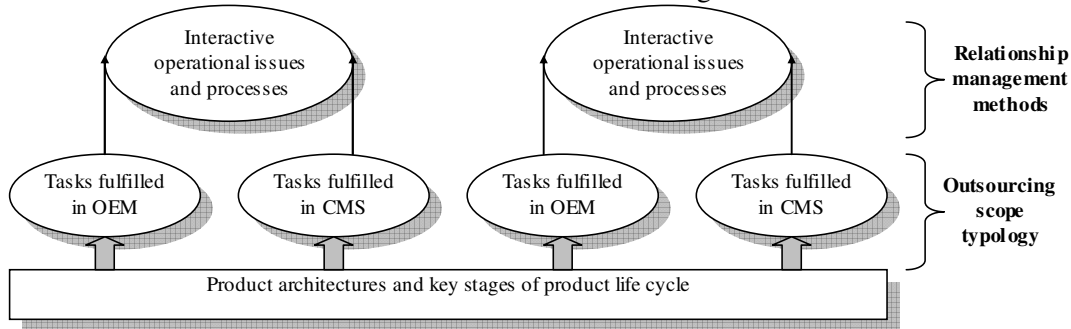


Figure 4: Structure of data modules to be collected in fieldwork

- *Work afterwards:* the site visits and interviews are followed up by thanks letters. The notes are packed up into reports over which feedback is requested for their correctness and new questions may be raised to interviewees after reflection.

With regard to the case selection criteria, Creswell (2007) states that cases can be selected to show different perspectives on the problem, process, or the event. Eisenhardt (1989) notes that the cases may be chosen to replicate previous cases or extend the emergent theory, or to fill theoretical categories and provide examples of polar types. This certain replication logic will be used for this multiple-case study. It selects cases considering the following criteria:

- The span of product range: a broad range of mobile handsets are selected to capture the diversity of outsourcing scopes. Smart phones are not sampled as they have just emerged and prospered only recently (e.g. iPhone in 2008, Nokia N95/96 in 2009).
- Scale of OEM/CMS: different size of OEM and CMS companies are incorporated in the research.
- Type of CMS: EMS, ODM and IDH are the major types of CMS. We took samples of all these three types of suppliers.
- Sales channels: the market demands can influence OEM's make-or-buy decisions (e.g. Harrigan 1983, Canez 2000). Mobile handset vendors usually take different practices in product development/production with sales through operators and distributors (Zander and Anderson 2008).

The companies studied in this research are listed in Table 2. The ones with no direct contacts or physical visits but being explored through telephone interviews and the interviews with their supply chain partners are labeled in brackets. The physical visits and interviews are carried out according to the cases' significance to the research questions and the access to the contacts. The value of selection criteria of the studied cases is presented in Table 3.

Table 2: Studied case companies

|         | OEM       | CMS                     | Upstream suppliers      |
|---------|-----------|-------------------------|-------------------------|
| Case M1 | Company M | Company F               | Cable and connector     |
| Case M2 | Company M | (Company Q)             |                         |
| Case U1 | Company U | Company S               | Camera module supplier  |
| Case U2 | Company U | Foxconn, (EastCom, TCL) |                         |
| Case T  | Company T | Company F, local EMS    | Display module supplier |

Table 3: Value of criteria in the selected cases

|         | OEM size | CMS size         | CMS type | Product category      | Sales channel       |
|---------|----------|------------------|----------|-----------------------|---------------------|
| Case M1 | Large    | Large            | EMS      | 2G Feature            | Operator customized |
| Case M2 | Large    | Large-Medium     | ODM      | 3G basic              | Distributor         |
| Case U1 | Medium   | Small            | IDH      | 2G-2.5G basic/feature | Distributor         |
| Case U2 | Medium   | Large and medium | EMS      | 2G-3G basic/feature   | Operator customized |
| Case T  | Small    | Large and small  | EMS      | 2G basic              | Operator customized |

- The method of data collection is selected to meet the research inquiry. As it sets to understand 'how to outsource' question, the archival records that contains more quantitative evidence is not a necessary approach.

To analyze the data, this research conducts with-in and cross case analysis. It categorizes the interviews into subsections and aggregates the data in the way that allow patterns to emerge uniquely from each case. Similar analytical procedures are followed repeatedly in every case. For the exploration of outsourcing arrangements categorization, the researcher compares the patterns generated from within-case analysis to illustrate the replication and variations of the

outsourcing scopes. Also the characteristics of the relationship management elements are compared to answer the ultimate research question.

## **4. Case Description and Analysis**

### **4.1 Case of Company M**

Company M is a world top multinational telecommunications company based in Illinois, US. It designs, manufactures and sells wireless network infrastructure and terminals. The annual revenue reported to be US\$ 30 billion in 2008. Its business is divided into three divisions, i.e. enterprise mobility solutions which offer communications products and systems to government and public safety sectors and enterprise mobility business, home & network mobility which produces digital entertainment, information and communications system for civilian application, and mobile devices that design and develop wireless handsets/systems and associated technologies.

Company M built a strong presence in mobile handset development and manufacturing. Over the decades, it has been ranked among the world top mobile phone vendors, occupying around 15% of global market share with a sale of over 150 million units in 2007.

Most of M's handsets concentrate on higher-end market segmentations. There have been concerns since the early 2000s when Company M's products were not designed to cater the demands of increasing customers in emerging markets. Together with the cost pressure and M's strategic focus on R&D, the production and related operations have been outsourced to EMS since 2001. In 2004, Company M also began to purchase complete design and full devices from Taiwan-based ODMs. Now over 50% of the M's handsets are produced or designed externally.

We selected two typical product models to describe Company M's outsourcing arrangements and related management issues, which are model MK and model X. They are outsourced to Company F and Company Q respectively.

#### *Case of Model MK (Case M1)*

MK is a model designed for use with iDEN (Integrated Digital Enhanced Network). The technology it adopts is TDMA (Time Division Multiple Access), mainly used for construction, public security communications etc. The network is operated by fewer and smaller carriers comparing to GSM/CDMA network. But it is still well supported as the speed of iDEN's Push-To-Talk (also known as Dispatch) feature is unparalleled, and remains the fastest in the industry.

Targeting at the mid-end market segment, the MK model is designed to fulfill a rich set of functionalities. It is shaped in the clam-style and features with an improved camera with an increased resolution of 1.3 Mega Pixels. The color display LCD, STN for external screen and TFT for internal screen, is a hot selling point as well. Together with wider band spectrum, MP3 support, external music controls etc. this model remains a hot-selling iDEN phone since its release.

With the design continued popular on market, it sells for a relatively long life cycle. The variations of this phone were released for different carriers as a replacement for the former

models, first for SouthernLINC networks and then for Sprint's Nextel iDEN Networks. However, due to the relatively smaller group of subscribers using iDEN, this model is produced with low to mid volume with certain variations on, for example, the coating of the mechanical exteriors, color and materials of the housing etc. It mainly sells in the US and South American markets.

Company M calls MK model as 'internal' project, as M keeps most of the industrial design, software and hardware design in-house. However the process of product development and production becomes more complicated and fragmented due to the intensive outsourcing activities. Mobile handsets are all developed with the guidance of M's internal product strategy, mainly to determine the long term technology roadmap and framework of platform used for a series of product models. The decisions of product strategy are made 24 months in advance of the specific model's market release. Besides building up the strategy, the software component and hardware pre-development should be carried out before the specific project is officially started.

Company F has mainly three business models, traditional EMS, CDM and ODM. They are all implemented to fulfill orders of the MK model. The ODM mode is carried out for camera modules. CDM is known as contract design manufacturing, implemented for mechanical housing and keypads which are jointly designed by OEM and EMS. For mainboard assembly and the final system assembly, Company F conducts with traditional EMS mode. F has also developed PCB fabrication and layout re-design capability to serve the OEM in a vertical integrated mode.

To meet all special requests in NPI builds, Company F establishes a set of internal processes, known as FPLC (Company F Product Life Cycle), which are the fundamental guidelines of the daily operations in multiple functions of Company F. CDM, ODM and EMS projects should comply with the FPLC although each has its own refinement.

In the process of performing the above activities, Company M and F make efforts on managing a series of key operational issues to ensure the success of outsourcing. We approach companies with the relationship management elements identified from literature. Based on the case description, we made the modifications towards the original version of the management elements.

Firstly, it was shown in the interviews both Company M and F made adaptation to the network they are involved, which forms an important part in managing their interaction. The interviews with practitioners indicated that the ways how OEM and EMS collaborate or 'wrestle' sometimes to manage the upstream component suppliers seem to be more than just purchasing which is traditionally known as dyadic. Supply chain managers in Company M confirmed the necessity to introduce a new element to reflect the OEM-EMS adjustment to this network environment. Therefore we add 'network adaptation' to the original version of the framework. It incorporates the sub-elements of 'CMS network configuration' and 'coordination among CMS and upstream suppliers', as shown in Table 4.

Table 4: Sub-elements of 'network adaptation'

|  | <b>Management issues occurred in Company M case</b>   |
|--|---|
| <b>CMS network configuration</b>                     | <ul style="list-style-type: none"> <li>• The locations of NPI builds, module design team, mechanical design team, assembly in large volume in Company F</li> <li>• The dispersion extent between the above sites</li> <li>• Smooth transition from one EMS site to another</li> </ul>   |
| <b>Coordination among CMS and upstream suppliers</b> | <ul style="list-style-type: none"> <li>• Arrange purchasing methods for different customized subassemblies and components, based on comparison between M and F's bargaining power over upstream suppliers</li> <li>• Insert price masks between upstream suppliers and Company F during mass production</li> <li>• Give out some supply chain control to EMS during NPI builds</li> </ul> |

Secondly, as commented by Company F, the technology assistance from OEM varies when it is associated with product design, engineering design and validation testing. We then identify the sub-elements of 'technology/knowledge assistance' as in Table 5:

Table 5: Sub-elements of 'technology/knowledge assistance

|  | <b>Management issues in Company M case</b>  |
|--|---|
| <b>Assistance with product design</b>              | <ul style="list-style-type: none"> <li>• Assistance on mechanical part design</li> <li>• Tackling problems with technology interfaces</li> </ul>  |
| <b>Assistance with engineering problem solving</b> | <ul style="list-style-type: none"> <li>• Improve NPI builds performance based on EMS's report</li> <li>• On-site support and fix the shop-floor problems promptly</li> <li>• Continuous process improvement during mass production stage</li> </ul> |
| <b>Assistance with validation testing</b>          | <ul style="list-style-type: none"> <li>• Set the contents and standards of validation testing</li> <li>• Support over specialized testing</li> </ul>  |

Therefore we propose a refined framework of relationship management elements as shown in Figure 5. The new constructs are labeled as *italic*.

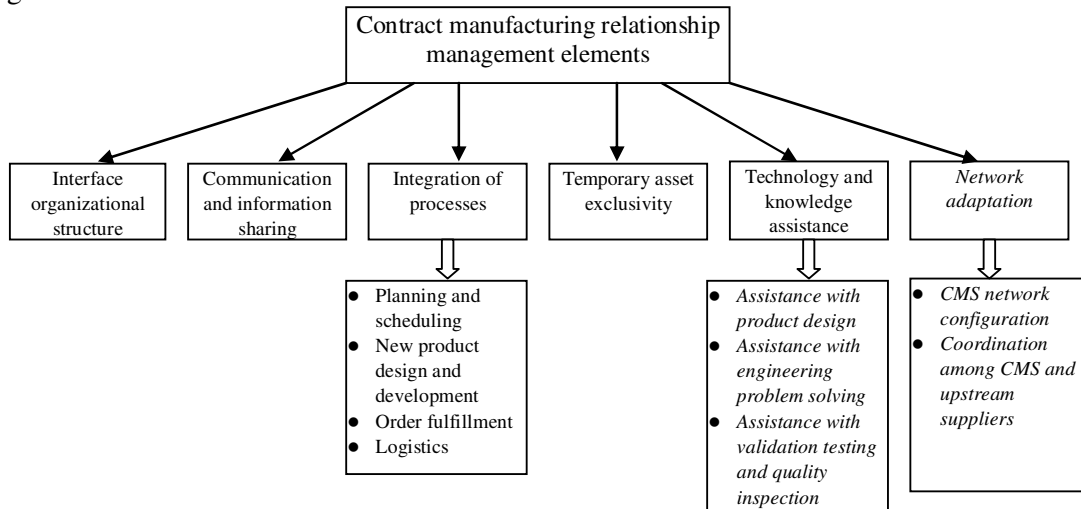


Figure 5: Elements of relationship management in contract manufacturing

*Case of Model X (Case M2)*

Model X was released by Company M in the April of 2008. It was among the first handsets in Company M powered by Qualcomm UMTS 3G chipsets. Among the major three streams of 3G standards (i.e. WCDMA, supported by European and Japanese carriers and vendors who were once based on GSM system; CDMA2000, backed by US and Korean manufacturers and carriers; and TD-SCDMA, supported by operators and device vendors in China such as DaTang, Siemens etc.), Company M deploys its terminal devices to be based mainly on W-

CDMA network. UMTS (Universal Mobile Telecommunications System) is one of the 3G mobile telecommunications technologies with W-CDMA as the underlying air interfaces. It belongs to GSM family and is being developed into 4G technology, also known as 3.5G. Mobile handsets based on 3G network can offer a wider range of more advanced services, including wide-area wireless voice telephony, video calls, and broadband wireless data transfer.

With the BOM cost double times as much as that of GSM/CDMA handsets, W-CDMA handsets are usually known as the high-end products. To complete its product portfolio and expand its relationship with Qualcomm, a world leading chipset vendor specializing in CDMA-based and UMTS chipsets, Company M decided to launch the Qualcomm-based model X to target low to mid-end market segments. Formerly, Company M's products mainly adopted TI and Freescales' solution and made an early entry into 3G markets with its first 3G handset launched in 2002. It now seeks to rationalize the company's cost structure as well as to pursue UMTS opportunities. Hence it steps to design Qualcomm's chipsets into its mid- and low-tier UMTS handsets.

Although aimed as a low cost product, this model still looks to possess rich multimedia functionalities. It features with candy bar shape, which is designed for lower cost than clam-shell or sliding phone. This model will be sold through distributor channels as well as operator-customized mode. It is shipped to European and Asian markets first and then to North America at a later date, carrying a FOB (Free On Board) price of around US\$ 100.

Model X is the first 3G handset in Company M using ODM supply. Before model X, Company M has a long history cooperating with Taiwan-based ODM, including Compal Communications Limited and BenQ Ltd. for 2G and 2.5G products for over 5 years. Since the year of 2008, Company M has outsourced model X to Company Q, also a Taiwan based ODM. The main considerations are in two aspects.

First is due to Company Q's expertise in developing customized handsets for telecommunications operators in Europe. The European markets set highly demanding regulations over mobile handset and its production processes, such as compliance with RoHS (Restriction of Hazardous Substances) and WEEE (Waste of Electrical and Electronic Equipment) Directives. Company M relies on Company Q for this specific model targeting European markets.

Second is the unavailability of internal experience on developing the new model. Unlike the more matured 2G products, 3G handset is still short of platforms for cross-model software and hardware development economically. The integration of chipset components and lower part count has become the trend to make 3G handset further cost-efficient. However the changing demands cannot be fully satisfied with Company M's internal capabilities. 'Because we have not sufficient development resources for such low cost 3G handset at this time, outsourcing to Company Q will help to improve time-to-market and cut learning curve.' as put by a Supply Chain Program Manager in Company M. Through outsourcing, OEM can minimize its risks in establishing its internal facilities and talents while develop a comprehensive portfolio of products. The whole product development cycle in M takes as long as 18~24 months, while ODM may use 1 year or less than 6 months for low end handsets.

The empirical data in this case enable us to further develop the six constructs of relationship management. The observation shows that the element of 'temporary asset exclusivity'

incorporates more than referring to the fixed assets such as equipments and instruments on the production lines. It can be viewed as comprising of tangible and intangible assets. By intangible assets, it refers to the knowledge assets, or specifically the design schemes on handsets' appearance, mechanical or hardware/software design. Once developed, they have become the assets that can generate value through reutilization among different customers. It is defined as in Table 6.

Table 6: Definition of new sub-elements in temporary asset exclusivity

|   | Definition  |
|---|---|
| <b>Temporary exclusivity of tangible assets</b>   | This sub-element refers to OEM's temporary exclusive utilization of the fixed assets in CMS such as: <ul style="list-style-type: none"> <li>• Factory</li> <li>• SMT lines and associated equipments</li> <li>• Manual assembly lines and associated equipments</li> <li>• All testing and inspection instruments</li> </ul>  |
| <b>Temporary exclusivity of intangible assets</b> | This sub-element refers to OEM's temporary exclusive utilization of knowledge assets developed and accumulated in CMS such as: <ul style="list-style-type: none"> <li>• Product concept, appearance, and mechanical design</li> <li>• Design of handsets' hardware and software within selected platform</li> <li>• Design of the modules or components, or the interfaces between the full device and key modules</li> </ul> |

Hence the refined version of the contract manufacturing relationship management constructs is presented in Figure 6, with the new inputs labeled in italic.

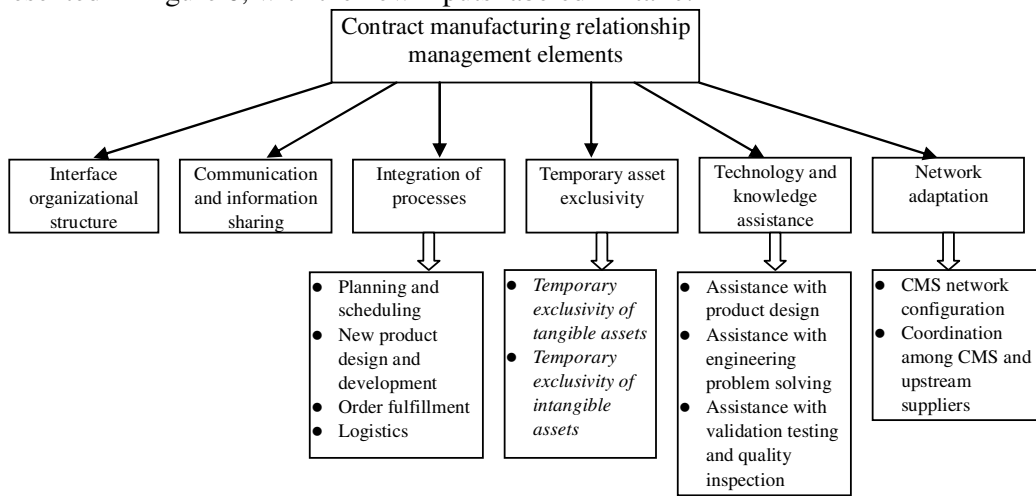


Figure 6: Elements of relationship management in contract manufacturing

#### 4.2 Case of Company U

Company U was founded in 1995 with the merger of two telecommunications high-tech enterprises in Silicon Valley. Although officially based in Alameda, California, the Company set its major market in China and established its PRC headquarter in Hangzhou, Zhejiang Province, east China (Yangtze River Delta Region). It designs, manufactures and sells telecommunications infrastructure, handsets and customer premise equipment with its own brand name. Its main products and services are associated with IP based end-to-end solutions, with annual revenue reported to be 1.6 billions USD and over 4000 employees in China.

Company U established its brand awareness through its Personal Access System (PAS), which provides wireless communication through access to fixed-line network. Company U

established the Personal Communications Division (PCD) to provide wireless communications terminal devices. PCD is based in Hauppauge, New York, and maintains offices and support facilities throughout the U.S., Canada, Latin America, Korea and India. In March 2005, PCD was licensed with the Mobile Handset Manufacturing Permit in China, and launched the construction of mobile handset production lines with annual capacity of 42 million units in Hangzhou.

The manufacturing base was built for the sale throughout not only Chinese market, but that in North and South America. However, the shrinking of PAS market since 2006 has seriously affected the decisions over mobile handset production. Company U started to shift its PCD business from PAS to GSM/CDMA/3G mobile handsets. A series of strategic moves towards outsourcing have been made accordingly.

As a late comer, Company U decided to gain fast entry into the market through cooperating with third-party original equipment manufacturers, or original design manufacturers. Currently Company U cooperated with mainly three vertically integrated IDHs, including Wingtech Limited, Longcheer Holdings Limited, as well as Company S, all among the top 5 handset design houses in China with strong system design and development capability to enable shortest possible time-to-market.

In addition, Company U has accumulated in-house product technology and supplied multiple carriers in the U.S. and Canada with its internally developed handsets since 2005. Some of them adopted the production outsourcing as well. In this section, two types of product series, GSM and CDMA mobile handsets, are focused to understand Company U's outsourcing arrangements.

#### *Case of GSM (Case U1)*

Company U started its production of GSM products since its strategic focus on handset market in 2005. Although the market share is not considerably high, this product line contributes to a complete portfolio, covering from feature phone to low end handsets, with the emphasis on the former. Company U's GSM products are mainly sold to Chinese market through national distributors' channels.

GSM, as the 2G products, feature with the following characteristics:

- Higher market share as compared to CDMA (75% VS 25% or so)
- More established players, world top handset vendors as well as domestic ones
- Developed supply base for key parts enabling local sourcing
- More matured and modularized design for both feature phone and low entry level

The above characteristics on one hand have lowered down the barriers for Company U's entry into GSM sector, while on the other hand, increased the difficulties for the Company to differentiate and establish its own brand. Currently, the quantity of GSM products' shipment units is around 15% of that for CDMA and PAS.

#### *Case of GSM (Case U2)*

In 2005, Company U started its first CDMA series with internal design and manufacturing for North American and Latin American markets that enable an end-to-end carrier-to-consumer solution. The annual shipments reached to 7.3 millions units, accounting for 50% of PCD's

annual revenue that year. Up to now, Company U's CDMA handsets are shipped an average of 300k units per month, with a mid to high volume of production.

There are mainly two characteristics for CDMA products:

- The handsets are largely sold through carrier channels in North America and South America. As the CDMA infrastructure solutions provider, Company U keeps a strong relationship with tier one operators such as Verizon Wireless, Sprint PCS, ALLTEL, US Cellular, Bell Mobility, Telus, BellSouth International, Telefonica, Virgin Mobile, and MetroPCS. Company U is known as the only handset provider to sell to every CDMA carrier in North America. Its quarterly shipments have reached more than 1.5 million units in the late 2000s.
- The development of CDMA handset families in Company U emphasizes on the application of cutting-edge product technologies, instead of adopting matured technologies for cost efficiency. For example, it has released 3G products based on CDMA2000 standards, and recently launched its next generation ultra-thin, bar-style camera phone. Company U sets its CDMA handsets to be mainly supply high/mid-end market segments.

The sales channel through carriers leads to higher extent of product customization. Global carriers usually raise more customized requirements, which increase the variants on appearance, such as keypads with special hot key or front cases with operator's logo etc. and deepen software differentiation especially on languages, menus and user interfaces.

#### **4.3 Case of Company T (Case T)**

Company T is a subsidiary of T Corporation. T Corp. is a major privately owned Chinese conglomerate that designs, develops, manufactures and markets a wide range of the electronic, telecommunications, information technology and electrical products. Its business includes mobile phones, personal computers, home appliances, electric lighting, and digital media sold to domestic and overseas markets.

Mobile handset has become a profitable business in T Corp. To catch the opportunity, Company T was founded in 1999, also based in Huizhou, Guangdong province, initially known as T Mobile. It was among the first Chinese domestic mobile handset manufacturers who were licensed with production certificate. The heated domestic markets during early 2000s helped Company T to gain strong momentum. In 2004 the former T Mobile made a major move to global markets by setting up a joint venture with Company A, a world leading French telecommunications organization. The new entity is called TCT. T Mobile owns 55% of the joint venture. TCT manages the brands of both T and A's mobile handsets. It is believed to bring benefits for both parties with complementary markets, brands enhancement, combined talents in handset development, and manufacturing synergies creating greater economies of scale. We use 'Company T' to refer to TCT in this research.

Company T made annual revenue of around 700 millions USD in 2008. As its domestic market share was shrinking due to the entry of so-called 'black mobile handsets' (the Chinese indigenous manufacturers with extremely strong ability to produce cell-phones at lowest price in shortest time), Company T shifted to target overseas markets including Brazil, Mexico, Spain, Italy, Netherlands, especially though cooperating with operators in emerging markets. It was reported that in first half of 2007 Company T shipped around 12 millions units with over 90% exporting overseas. The dominance over global emerging markets has helped Company T survived the more intensive domestic competition and witnessed shipments increased over 60% in 2008.

Company T maintains its internal production facilities mainly in Huizhou, within 2 hours' distance to Shenzhen, the major portal city and low labor electronic manufacturing base in southern China. With the presence of the former Company A's production in Mexico, the handsets with brand T and A were available in some Latin American countries, including Mexico, Central America, Chile, Peru, Bolivia, Paraguay, Uruguay and Argentina. To enter into Brazil market, Company T started outsourcing to Company F in the end of 2006. The cooperation was originally to support Brazilian markets only. Currently there is only 10 percent of business is completely outsourced to Company F. Nevertheless, this proportion of outsourced business is planned to increase in the coming years as Company T looks to support the whole Latin American markets with F's production lines only. The current relationship between manufacturing sites and their market support is demonstrated in Figure 7:

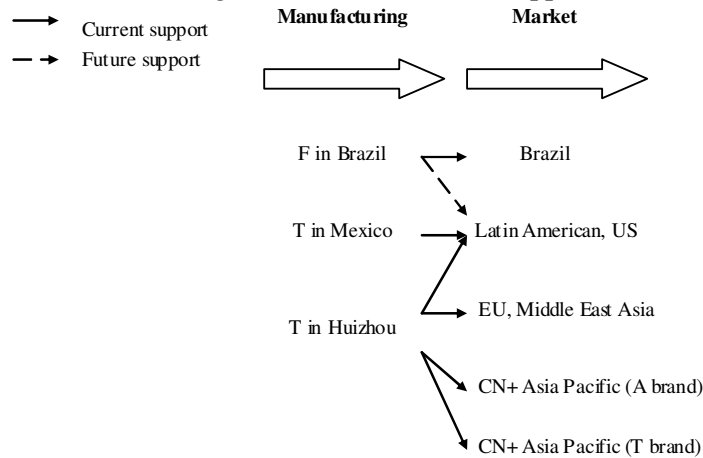


Figure 7: T and F's manufacturing sites and markets they support

The products that supplies Latin American markets are the ones with most outsourcing activities in Company T. These series of handsets are mainly local carrier customized models, which are directly distributed through carrier's channels. As price sensitivity remains a deciding factor in the purchasing decision for many consumers in emerging markets, entry level GSM mobile handsets remain to be hot-selling.

Company T provides GSM entry level phones all based on TI and MTK platform. The former can provide single chip solution that integrates RF, baseband and DSP into one single IC, which costs for less than 10 USD per unit. The latter is known for its turnkey chipset solution which shortens the product development time to only 3 months. For further cost saving, camera modules are not incorporated, as required by operators. The phones are designed to provide minimal features with voice-centric functionality only. The single chip design and reduction in the number of components lowers the BOM cost per unit to no more than 30 USD, which is known as Ultra Low Cost Handset (ULCH).

The order fluctuation from the overseas carriers is relatively high, partly due to the market competition. The 1990s trend of privatization and liberalization in Latin American telecommunications sector has brought the intensive competition between foreign as well as domestic operators. Company T is still working to strengthen the relationship with customers in order to gain higher volume of production and lower order fluctuation.

#### 4.4 Data analysis

This section carries out the cross case comparison to understand the outsourcing scope and define different contract manufacturing arrangements. We compare them in two dimensions:

- One is the scope of Product Architectural Level (PAL), representing at what architectural level (i.e. full system, module or component level) that the product is outsourced to contract manufacturers.
- The other is the span of Product Life Cycle (PLC), meaning what PLC stages are taken over by contract manufacturers.

The architecture of the products with modular design can be divided into three levels: full system/device level, module/subassembly level, and component level, as shown in Table 7. The scopes of activities in contract manufacturing are mapped against the PAL.

Table 7: Decomposition of mobile handset PAL

|                               | Major hardware contents  |
|-------------------------------|--|
| Full system level             | Engine with basic communication functionalities, full device with customized software, full commercial package with manuals and external accessories     |
| Module/<br>sub-assembly level | Main board (PCBA), display module, camera module, RF/Base-band units, mechanical exteriors, memory, power units, others (e.g. battery, accessories etc.) |
| Component level               | PCB, chips, mechanical parts/ tooling, others (e.g. discrete components, connectors/ cables etc.)  |

Product life cycle (PLC) is utilized to map different ranges of activities conducted in OEM and CMS. Based on the empirical data, we present the PLC stages and their major tasks in Table 8, which covers the whole process from the product being defined, introduced through to volume production and phasing out from the market.

Table 8: Decomposition of PLC and associated activities

|                                    | Major activities  |
|------------------------------------|---|
| Concept and product definition     | <ul style="list-style-type: none"> <li>- Define product within the platform</li> <li>- Align product and modules with technology roadmap</li> <li>- Verify and issue proposal for design</li> <li>- Specify features of major functional modules</li> </ul>   |
| Initial product design             | <ul style="list-style-type: none"> <li>- Conduct industrial and mechanical design</li> <li>- Main board hardware design, software design</li> <li>- Decide BOM</li> <li>- Design general MMI, major interfaces with key subassemblies</li> </ul>  |
| Prototyping and validation testing | <ul style="list-style-type: none"> <li>- Organize and qualify supply of component and module samples</li> <li>- Build prototype of main board with basic software functionalities and full product prototype with system completely available</li> <li>- Carry out reliability testing for engineering and design validation</li> <li>- DFX (design for fabrication/assembly/engineering etc.)</li> </ul> |
| Pre-production                     | <ul style="list-style-type: none"> <li>- Run pilot series from first-off through to small volume of units</li> <li>- Process validation testing and refine the design of production processes</li> <li>- Approve process capabilities and ensure quality in production</li> </ul>   |
| Mass production                    | <ul style="list-style-type: none"> <li>- Fulfill requirements of volume production</li> <li>- Carry out quality control compliant to customers specifications</li> <li>- Continuously improve production process</li> </ul>   |
| Phase-out                          | <ul style="list-style-type: none"> <li>- After-sale support</li> <li>- Repair during phase-out</li> </ul>   |

The scopes of PAL and PLC form the two dimensions of outsourcing scope in contract manufacturing. They form the vertical and horizontal axis of a matrix to facilitate the typology of contract manufacturing arrangements. The matrix and the case positions are demonstrated as in Figure 8. ‘Scope’ of PAL/PLC refers to the range of tasks associated with the levels of product architectures and product life cycle stages which are outsourced to CMS.

The scopes of outsourcing can be viewed as a continuum, where one pair of OEM-CMS may have the selection to outsource with any scopes along the continuum. However, the cross case analysis suggests that there are certain patterns that these outsourcing arrangements may follow. The three groups of cases represent three typical types of contract manufacturing arrangements, which are named as Manufacturing Task Outsourcing, Package Outsourcing, and Full Outsourcing, as shown in Figure 8.

- **Manufacturing task outsourcing:** outsource production at MP stage, keep internal production for prototypes, process designs and testing facilities; outsourcers constrained in PCBA or full box assembly tasks.
- **Package outsourcing:** leveraging EMS vertical integration capabilities and reduce the supplier tiers, EMS can supply PCB fabrication, housing, mechanical tooling, camera module assembly etc. EMS integrates the roles of contract manufacturer and customized suppliers, second tier suppliers to OEM. VI outsourcing compresses SC and eliminates profit margin layers.
- **Full outsourcing:** leveraging outsourcee's product development capabilities to further increase the supply chain modularity. ODM or IDH provides full system design, production, and the end-to-end solution to OEM through the whole product life cycle.

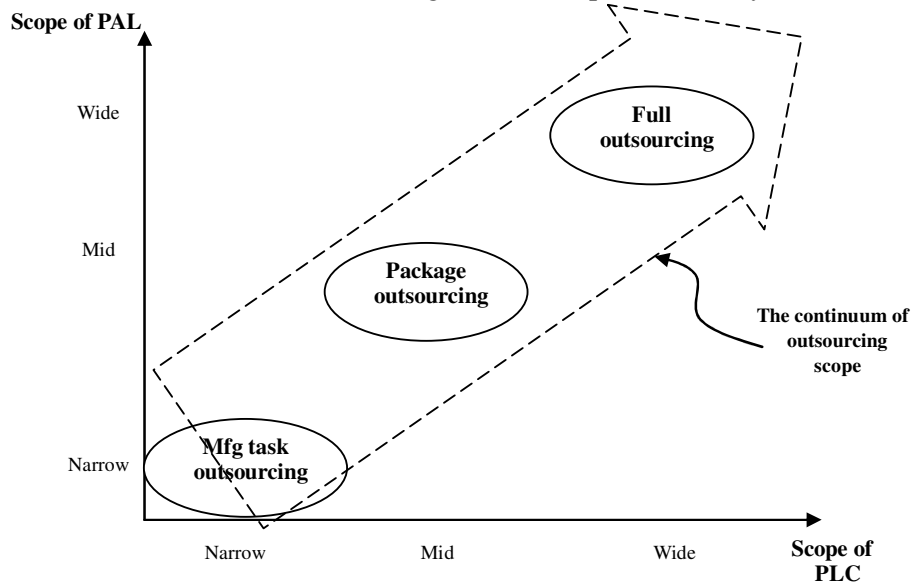


Figure 8: Typology of contract manufacturing

The conditions for the employment of different outsourcing arrangements include product characteristics, OEM's motivation, and the most valued CMS's capabilities. They are demonstrated in Table 9, as summarized from the case description:

Table 9: Scenarios for outsourcing arrangements

|                                |         | Product characteristics  | OEM's outsourcing motivation  | Most valued CMS's capabilities   |
|--------------------------------|---------|--|---|--|
| Manufacturing task outsourcing | Case U2 | <ul style="list-style-type: none"> <li>● Mid to high volume</li> <li>● Higher extent of customization</li> <li>● Sold through carrier channels</li> <li>● Cutting-edge product technologies applied</li> <li>● Targeting mid to high end market</li> </ul>                           | <ul style="list-style-type: none"> <li>● Gaining sufficient capacity without extra investment</li> <li>● Removing cash flow pressure by 'factory outsourcing'</li> </ul>  | <ul style="list-style-type: none"> <li>● Expertise of manufacturing with knowledgeable operators</li> <li>● Smooth and fast transition to mass production</li> <li>● Cost down by economies of scale</li> </ul>  |
|                                | Case T  | <ul style="list-style-type: none"> <li>● Higher volume, lower mix</li> <li>● Sold to emerging market through carrier channels</li> <li>● Low end market segment with higher price sensitivity</li> <li>● Matured product and process technology</li> </ul>                           | <ul style="list-style-type: none"> <li>● Gaining access to overseas market with high tariff</li> <li>● Balance capacity during peak time</li> </ul>   | <ul style="list-style-type: none"> <li>● Wide global dispersion</li> <li>● Smooth and fast transition to mass production</li> <li>● Cost down by economies of scale</li> </ul>   |
|                                |         | Product characteristics  | OEM's outsourcing motivation  | Most valued CMS's capabilities   |
| Package outsourcing            | Case M1 | <ul style="list-style-type: none"> <li>● Produced with low to mid volume</li> <li>● Certain degree of design variation mainly on appearance</li> <li>● With smaller groups of subscribers in the mid end market</li> <li>● Supported by fairly matured product technology</li> </ul> | <ul style="list-style-type: none"> <li>● Save labor cost and transportation overhead due to cost pressure</li> <li>● Shorten time-to-market by outsourcing to one single CMS with full spectrum services</li> <li>● Strategically focus on R&amp;D and high end products</li> </ul> | <ul style="list-style-type: none"> <li>● Vertical integration capabilities sustaining internal supply</li> <li>● Strong engineering capabilities to enable rapid ramp-up</li> <li>● Module level design and engineering expertise</li> <li>● Readily available testing capabilities</li> <li>● Supply chain coordination capabilities</li> </ul> |
|                                | Case M2 | <ul style="list-style-type: none"> <li>● Targeting larger group of end customers at low to mid end market</li> <li>● Lower BOM cost comparing to same generation products</li> <li>● New product technology applied</li> <li>● Strict regulations of the regional markets</li> </ul> | <ul style="list-style-type: none"> <li>● Rapid market penetration without risky investment</li> <li>● Maintain a complete product portfolio</li> <li>● Pursue new technological opportunities with rationalized cost structure</li> </ul>   | <ul style="list-style-type: none"> <li>● Substantial experience on the specific regional market</li> <li>● Expertise of the product design with certain platform</li> <li>● Long-term supply of other generations of products</li> <li>● Rich sourcing channels and supply chain coordination capabilities</li> </ul>                            |
| Full outsourcing               | Case U1 | <ul style="list-style-type: none"> <li>● Lower volume of production</li> <li>● Mainly supply domestic markets at mid to low end</li> <li>● Matured product and module technology</li> </ul>  | <ul style="list-style-type: none"> <li>● Quick entry into the market as a new player</li> <li>● Complete the product portfolio</li> <li>● Shorten time-to-market as much as possible</li> </ul>   | <ul style="list-style-type: none"> <li>● Strong system design and development capability</li> <li>● Shortest possible NPI lead time</li> </ul>   |

Six elements of relationship management between OEM and CMS are identified from operational perspective. They are interface organizational structure, communication and information sharing, integration of processes, temporary asset exclusivity, technology/knowledge assistance, network adaptation. Some of them are comprised of several sub-elements. They are the factors that the executives should carefully consider when manage the corresponding issues.

Comparing to the preliminary framework in Section 2, the new one is mainly refined from the following aspects:

- Firstly, add a new element of 'network adaptation'. This is to describe the efforts of OEM and CMS to adapt the dyadic relationship to a networked environment. This element mainly include the adaptation to the geographically dispersed production network in CMS; the dynamics of relationships between OEM, CMS and upstream suppliers, reflecting the way OEM and CMS coordinate the production/supply networks.
- Secondly, within the element 'technology and knowledge assistance', the issues highlighted by the interviewees are summarized into the sub-elements of assistance to product design,

engineering, and validation testing. They address the focuses in managing the technology transfer or assistance between OEM and CMS.

- Thirdly, the field interviews suggest that temporary exclusivity of tangible and intangible assets should be included as the sub-elements of the 'temporary exclusivity of assets'. They were underpinned to reflect CMS's emphasis on how to allocate its assets across clients.

As discussed in Section 2, the production network with involvement of contract manufacturers is a typical modular organizational form (Sturgeon 2002). Be it in product or organizational architecture, the concept of modularity is always used to specify the attributes of interfaces (Ulrich 1995, Baldwin and Clark 1997, Sako 2003, Fixson 2005). Since the relationship management elements summarized above are essentially a set of considerations across the interfaces, we use the concept of modularity to make comparison between the characteristics of relationship management.

The relationship is managed in a more modular (less integral) way when:

- 1) There is a clear boundary definition to the tasks and the functional teams that carry out them between OEM and EMS;
- 2) There is a lower extent of involvement/influence from either side of buyer or supplier in coordinating and controlling the processes, intensity of information sharing, amount of knowledge and technology in transfer etc.; or
- 3) The forms of interaction and information in exchange are standardized, codified or regular.

Therefore we name the three types of collaborative relationship management methods based on the modularity degree as follows:

- ***Integral collaborative relationship management***: represented by the OEM-CMS relationship management methods in Case U2 and T. It refers to the way where a big portion of management issues at the OEM-CMS interfaces are coped with more influence from OEM through the less standardized/ pre-defined processes spanning the boundary.
- ***Modular collaborative relationship management***: represented by the OEM-CMS relationship management methods in Case M2 and U1. It refers to the way where CMS possesses greater control in dealing the management issues at the interfaces. The interaction processes or information in sharing are more standardized and well-defined. OEM maintains (or intends to maintain) control at all levels at distance.
- ***Intermediate collaborative relationship management***: represented by the OEM-CMS relationship management methods in Case M1. It refers to the way that OEM tackles most interface management issues with moderate extent of influence compared to the above two types. The operational interaction processes can be pre-defined and standardized sometimes but not fully codified as in 'modular collaborative relationship management'.

Case M1 presents the situation where package outsourcing is linked with intermediate relationship management; in Case M2 and Case U1, OEM and CMS adopt modular relationship management in full outsourcing arrangement; Case U2 and Case T show that in manufacturing task outsourcing context, integral relationship management method is likely to be implemented.

## 5. Framework and Findings

The final framework maps the three types of outsourcing scopes with contract manufacturing relationship management methods. It combines the three key findings. The typology of

outsourcing arrangements is developed to understand the complex and dynamic context of OEM and CMS collaboration. To ensure the success of outsourcing implementation, the executives from both OEM and CMS should take different measures managing the six elements identified above. This research implicates that various degrees of modularity exist in the collaborative relationship management approaches. They are closely associated with the different outsourcing arrangements.

- In **Manufacturing Task Outsourcing** scenario, the **Integral Collaborative Relationship Management** method is likely to be implemented. Under such circumstance, the CMS tends to assume limited range of responsibilities which mainly focuses on the manufacturing tasks for mainboard, sometimes full device, during mass production stage. With the cost control as the major driving forces, OEM and CMS manage the collaboration in a more integral approach. It features with less modularity in organization, communication, operations, and supply chain coordination, addressing the stronger influence and control from OEM in carrying out the activities such as planning and scheduling, order fulfillment, upstream supply chain coordination, production network structure design etc.
- In **Package Outsourcing** scenario, the **Intermediate Collaborative Relationship Management** method is likely to be implemented. This arrangement allows CMS to extend its range of activities and deliver it as the service package. It incorporates the box-building and specific design tasks for full device, mainboard and some key modules/components with an early involvement in the product life cycle. The integrated manufacturing and design outsourcing requires less involvement from OEM in operations and is sustained by higher standardization in the forms of communication and the organizational interface structure.
- In **Full Outsourcing** scenario, the **Modular Collaborative Relationship Management** method is likely to be implemented. CMS companies take over the full spectrum of the product design and manufacturing tasks throughout the whole product life cycle. This type of outsourcing arrangement gives the highest degree of autonomy in most operational issues to CMS. OEM maintains the least influence over decisions on planning and scheduling, order fulfillment, production network structure design, and upstream supply chain coordination. The relationship is managed in a more modular way where assets specificity is minimal and standardization of the communication form and interface organizational structure is highly demanded.

The final framework is presented in Figure 9. The three dimensional coordinate system shows the mapping between relationship management methods and the outsourcing scopes. The bottom plane is formed with scopes of PAL and PLC. The vertical axis reflects the degrees of modularity in relationship management which are composed of modularity in six aspects, roughly corresponding to the six relationship management elements

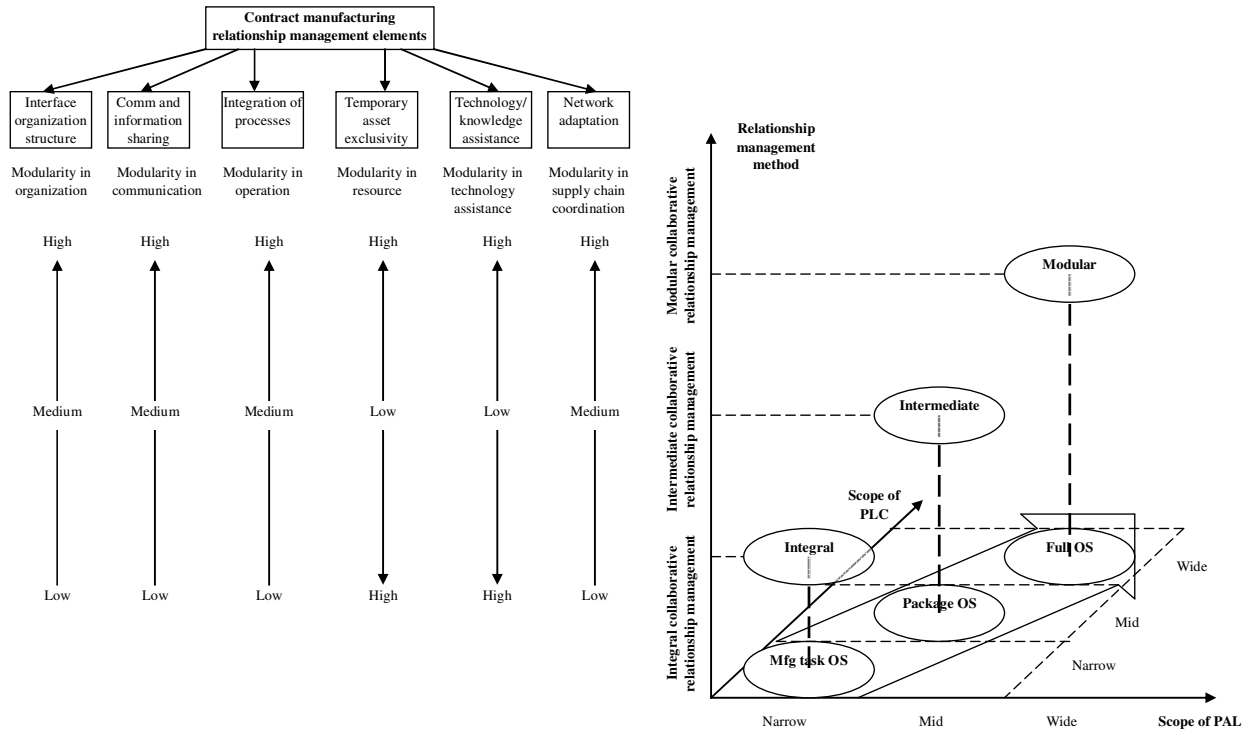


Figure 9: Final framework that integrates the three key findings

## 6. Conclusion

Existing theories in outsourcing mainly tackle the ‘make-or-buy’ decisions through transaction cost economies and resource-based strategies. As there remains relatively inadequate research into the outsourcing implementation stage, this research maps the outsourcing arrangements with the relationship management methods, with the focus on contract manufacturing in mobile handset industry. It demonstrates that outsourcing arrangements can be classified by the scopes into manufacturing task outsourcing, package outsourcing, and full outsourcing. They are correlated with three different relationship management approaches, which are integral, intermediate, and modular collaborative contract manufacturing relationship management methods respectively. Specifically, organizational structure, communications, process integration, technology assistance, temporary asset specificity, and network adaptation should be well considered to effectively manage the OEM-CMS relationship.

They are deemed to impact the theories in outsourcing and supply chain relationship management. Practically, executives in OEM and CMS, be they are in mobile handset sectors or not, may find it helps to proactively identify relevant management issues with a specific outsourcing arrangement. In the end of this research, it is suggested that across industry investigation can be implemented to extend its generalizability. Future work is also needed to explore the impacts of firm’s evolution towards the network, where CMS may provide an ideal subject.

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