



Ensuring quality in the production of electronic products in China

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Summary

This thesis project was commissioned by Comsel System Ltd, founded by Kristian Heimonen in 1989. Nowadays, Comsel System Ltd focuses on smart meters which help energy users to be even more energy efficient. To produce smart meters, Comsel System Ltd decided to outsource good quality printed circuit board (PCB) production to China. Seeking a proper electronic manufacturing service (EMS) provider and ensuring product quality was the main purpose of this thesis. The aim of this thesis is to find outsourcing companies which can provide PCB products with a good quality and price. Using a comparative approach to analytic research, the advantages and disadvantages of each company can be analysed and an appropriate EMS provider can be chosen to build a long-term cooperation. The result showed that the EMS company size should be small. The production capacity should fit the company product life cycle growth. The product lead time should be short. What's more, the price is very important when choosing a partner. The service is one of the important aspects which should include technical support and improvement result. By taking into account company size, specialized company products, product lead time, price and service, choosing a proper EMS for Comsel System Ltd can be achieved.

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Contents

1	Introduction	1
1.1	Comsel System Ltd	1
1.2	Thesis background	2
1.3	Vision.....	2
2	Outsourcing	3
2.1	Introduction to outsourcing.....	3
2.2	Outsourcing trends	3
2.3	Electronic products' outsourcing benefits	4
3	Choosing China	4
3.1	Chinese business environment.....	4
3.2	Chinese electronic industry	6
4	Chinese and Finnish business cultures	7
4.1	Finnish culture overview.....	7
4.2	Finnish business communication style.....	7
4.3	Chinese culture overview	8
4.4	Chinese business communication style.....	9
5	Products and outsourcing criteria	10
5.1	Product life cycle	10
5.2	Electronic manufacturing services (EMS)	11
6	Product quality.....	13
6.1	The manufacturer's quality control.....	15
6.2	The customer's quality control	16
7	Outsourcing of electronic products.....	17
7.1	Company requirements	18
7.2	EMS providers	18
7.3	Communication with the EMS provider	19

8	Analysis	19
8.1	Companies' basic information analysis	20
8.2	Key process capabilities.....	20
8.3	Product lead time	21
8.4	Service support and price.....	21
9	Result.....	21
10	Conclusion.....	22
11	References	24
	Appendices	28

Figures

<i>Figure 1. Sales revenues of electronics industry</i>	5
<i>Figure 2. Import and export value (2005-2012)</i>	6
<i>Figure 3. Product life cycle/13/</i>	10
<i>Figure 4. Worldwide EMS Market/15/</i>	12
<i>Figure 5. Meaning of quality /17/</i>	14
<i>Figure 6. Control chart</i>	16

1 Introduction

This thesis was commissioned by Comsel System Ltd. Mr. Kristian Heimonen was my supervisor at the company and Mr. Matts Nickull supervised my thesis at Novia. In recent years, climate change has become increasingly serious and temperatures around the world have increased. To fight against climate change, EU has made a 20/20/20 regulation plan. In principle, it means that the member states by the year 2020 need to reduce their use of fossil fuels with 20 %, reduce emissions of greenhouse gases by 20 % and increase energy efficiency to save 20 % of EU energy consumption. During the last few years, the electricity cost in homes has become a significant part of the household economy and of the living costs. Comsel System Ltd today introduces a smart meter which is the next generation of automation meter reading (AMR). A smart meter not only has the functionality of AMR but also has functions that can concretely help the energy users to be even more energy efficient, reducing the environmental impact and saving money. To produce smart meters, printed circuit boards (PCB) are very important and should be manufactured with a good quality. The electronic information industry in China grew rapidly after the liberalization of the economy under the national strategic policy of speeding up the “information” about the development of industry in China/1/. China has been the world’s largest manufacturing centre for the electronics industry for many years. It was in 1992 that China entered the electronics age. Since the dramatic change, both the big and small business firms from all around the world want to do business in China because of the cheap and skilled labour. Comsel System Ltd wanted to use the advantages of Chinese electronic industry and decided to outsource electronic products to China.

1.1 Comsel System Ltd

Comsel System Ltd was founded in Vaasa in 1989 by Kristian Heimonen. Initially, the operations comprised development and planning of automation equipment, network consulting, as well as planning and implementation of electricity installations.

Today, Comsel System Ltd works with the next generation of AMR solutions also called “Smart Meters”, which are part of the elements in the entirety of “Smart Grid”. The concept of Smart Meters comprises not only the AMR functionality, but also functions that can concretely help the energy users to be even more energy efficient, thereby reducing the environmental impact and saving money.

Comsel System Ltd also offers tools that give the energy user simple access to relevant information on users' own consumption, the supply of electricity, energy price information etc. By a standardized interface, the consumption can automatically be regulated in relation to the electricity price so that the smart meters are made under controlled circumstances.

1.2 Thesis background

To produce the new product smart meter, Comsel System Ltd decided to produce the PCBs in China and transport them to Finland. In this thesis, the process for new product production, prototyping, logistics from China to Finland and quality assurance of a new product in China are being studied.

Two decades ago, EU and China traded almost nothing. China's rise as a major global economy was boosted by its world trade organization (WTO) membership in 2001, which provided a platform for China to establish itself as the world's biggest exporter. Nowadays, China and the EU are trading more than €1 billion every day. As a matter of fact, the import of electronics from China is still a huge market in EU. Some EU companies make good use of the cheap labour and other advantages to produce high quality products and make profits/2/.

Therefore, this thesis will focus on the investigation of companies in Finland, the process for new product production, the logistics between China and Finland, and also the quality of products. The cheap labour and the favourable price for producing in China have made China into a remarkable market for the world. Since most large companies generate a subsidiary company in China, what should the small company do when outsourcing to China? How can the quality of products be ensured?

1.3 Vision

The main purpose of this thesis is to find out what should be evaluated when producing electronic products in China and to find the proper EMS provider to make sure the quality fits the customer's requirements. Lots of products in Finland are made in China and have a high quality level. However, the manufacturers and importers of electronics from China prefer mass production with a high quality and a low price. The thesis will briefly give an insight into how one could ensure the quality of low-volume products for small companies in Finland. Meanwhile, the product lead time also plays an important role when the

products are introduced on the market. As we all know, time is money. The shorter the products' lead time is, the faster the markets will response. How to shorten the product manufacture lead time, which logistics should be used to match the market trend should also be taken into account.

2 Outsourcing

Different companies have different specific business situations which might need outsourcing. For most executives, outsourcing is a smart strategy to better manage resources which will let them focus on the core competitiveness. This chapter will introduce outsourcing, outsourcing trends and benefits of outsourcing to clarify why the products need to be outsourced.

2.1 Introduction to outsourcing

Outsourcing is the contracting out of an internal business process to a third party organization. Outsourcing can involve transferring employees and assets involved in the business process from one company to another^{3/}. Companies outsource to avoid certain types of costs such as burdensome regulations, high taxes, high energy costs and unreasonable costs that may be associated with defined benefits in labour union contracts. Compared with overseas labour costs, the outsourcing companies do not need to pay for the higher labour costs and this motivates companies to outsource overseas. However, the company may or may not incur unexpected costs to train overseas workers^{4/}. Lower regulatory costs help companies save money when outsourcing. Nowadays, the outsourcing service market still flourishes in Central and Eastern Europe.

2.2 Outsourcing trends

Around the world, large companies try to become smaller in terms of employment. Many companies have outsourced personnel management, service, logistics and transport. Everywhere, companies are focusing on their "core competitiveness". Nowadays, manufacturing is not seen as such a core activity especially in highly technical industry. In a number of industries it still is. But in a sector such as automobiles, with highly standardized production processes and great differences in the labour-, capital- and skill-intensiveness of the different stages that make use of these processes, it is now common to

outsource many of these stages. Many companies resort to outsourcing because it helps them spread risks and lower costs. Outsourcing also enables the subcontractors to gain access to key technologies to reduce their need for working capital and to adjust their levels of production more flexibly by passing on the burden of idle overheads to subcontracting.

2.3 Electronic products' outsourcing benefits

The benefits of outsourcing are to spread risks and to lower costs. Nowadays, the intensely competitive nature of the electronics industry, the ever-increasing complexity and sophistication of electronic products, the pressure on the original electronic manufacturers (OEMs) to reduce cost as well as the shorter product life cycles have led to a rapidly growing demand for advanced manufacturing capabilities in order to remain competitive. OEMs focus on what they do best: production and providing the service. The benefits of outsourcing in electronics are summarized as:

- Reduce time-to-market and time-to-volume production for the companies' products
- Lower operating costs, reduce capital investments
- Access world leading manufacturing technology, engineering and logistics capabilities
- Focus on core competencies

3 Choosing China

As the previous chapter mentioned, outsourcing lowers the costs and spreads risks. However, where should companies outsource and why? Comsel System Ltd chooses China as the destination country for the manufacturing of products due to the Chinese business environment, cheap labour and skilled labour.

3.1 Chinese business environment

Chinese electronics industry has developed rapidly since 2001, posting double-digit growth rates until the global economic crisis hit in late 2008. But with the help from Chinese government, the industry began to gradually revive in the late half of 2009. Official statistics show that in the first half of 2010, the sales revenue of the electronics industry

reached RMB 2.86 trillion (USD 420.6 billion), increasing 23.8 percent year-on-year. Moreover, while the 2009 growth rate of the sales revenue dropped to its lowest point in history, it still plays an important role in Chinese GDP (gross domestic product) which contributes 10 % to overall GDP growth in 2009.

Table 1. China electronic industry

Defining Chinese electronic Industry	
Consumer electronics	Communication device
Electronic components	Radar device
Broadcasting/TV industrial device	Computer device/peripheral units
Electronic apparatus	Measuring instruments
Photoelectric apparatus	Electronic material

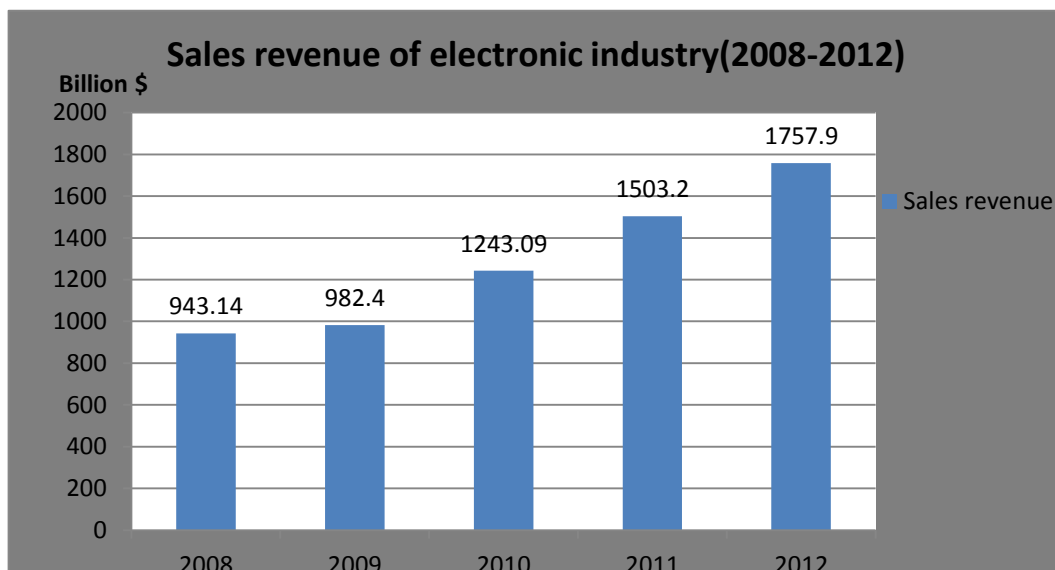


Figure 1. Sales revenues of electronics industry

Trade from China's electronics industry comprised more than 30 % of China's overall trade in recent years. Since China became a member of WTO, domestic electronics industry boomed gradually. Figure 1 shows that the sales revenues of the electronic industry grow significantly every year. The growing trend still exists and it also shows that more and more electronic products are produced in China. Figure 2 shows that the export

value grows very fast. The export value also indicates that Chinese export economy has a prosperous development.



Figure 2. Import and export value (2005-2012)

3.2 Chinese electronic industry

With the development of electronics manufacturing in China and the global electronics manufacturing shift to China, China has formed relatively complete electronics industry communities by Yangtze River, Pearl River and Bohai/5/. Every big brand company in all of the Industrial Park is surrounded by numerous small and medium-sized manufacturers. The development of infrastructure in those areas of China provides a strong support of manufacturing. Geographically, logistics in those areas are convenient and the industrial companies' supply chain is powerful, fast and integrated. What is more, the quality of the labour force is gradually improving and all industries have a 2-3 month pre-job training. Despite the rising cost of labour supply, China still has a relatively low-cost R&D and high-end talent. From this perspective, the Chinese manufacturing still has a sustained advantage.

4 Chinese and Finnish business cultures

Business culture, as the name suggests, is the culture in which people do business and interact with each other. Generally speaking, geography, history, economics and government are important factors in knowing a country culture. However, this paper focuses on the business communication between two countries when doing business and just briefly gives an overview of the two countries' culture.

4.1 Finnish culture overview

Finland, officially called the Republic of Finland, is a Nordic country located in Northern Europe. It is bordered by Sweden to the west, Norway to the north, Russia to the east and Estonia to the south. The population is estimated to be about 5.4 million. The majority is concentrated in its southern regions. Finnish and Swedish are the official languages of Finland, and all legislation and other official information is published in both languages, Finnish is spoken by 92.1 % of the Finns and Swedish by 5.6 %. Sami is the mother tongue of about 1,700 people/6/. Swedish is taught in schools to all Finns, and a good knowledge of Swedish is a necessary qualification for most public posts. With over 188,000 lakes and a northern climate, Finns have a dynamic appreciation for nature and enjoy the tranquillity of the countryside. Finland as the "land of a thousand lakes" is also well known for its education system, high standards of living, technology and healthcare and ranks high in global business competitiveness. Finland is a highly industrialized mixed economy with a per capita output equal to other European economies. The largest industries are electronics (22 %), machinery, vehicles and other engineered metal products (21.1 %), forest industry (13 %) and chemicals (11 %)/7/. There are two sectors in the tertiary education: universities and polytechnics in Finland. Finland has seen a continuous growth in tertiary qualifications over past generations, with 47 % of the typical age group completing a bachelor's or master's degree.

4.2 Finnish business communication style

Finns are known to be hard-working and highly educated, but their introverted nature and direct communication style can confuse newcomers. In order to do business successfully in Finland, it is essential for people to understand Finnish business etiquette. Appointments are necessary and should be made in advance by telephone or email before you want to

start a meeting. During the business meeting, Finns are expected to contribute to a meeting or conversation only when they have something of importance to say. Thus it is not unknown for a Finn to sit through a lengthy meeting without making any verbal contribution. This lack of contribution should not be confused with a lack of comprehension or interest. The Finn will respond when he or she feels it appropriate. Silence is an integral part of the overall communication pattern and Finns are more comfortable in silence than most other nationalities. In a negotiation situation, cultivate your own level of comfort in silence otherwise you can find yourself giving away more than was originally intended. Finnish body language tends to be very limited and therefore difficult to read. Over expressiveness in word or gesture is viewed with suspicion and it is better to temper one's own body language. Do not mistake lack of visible or verbal reaction to a presentation as showing disinterest. Finns use humour extensively in business situations (although less than the British, Irish or Australians), but the type of humour may bypass other nationalities' comprehension. The humour is usually very laconic and self-deprecatory and the Finns tell more jokes about themselves than any other nation/8/. The sauna has a special role in the domestic life of Finns and many important business meetings may be followed by a sauna in which the conversation is continued on a more informal basis. Usually, business cards are exchanged without formal ritual. The organization structure in Finnish companies is the same as in western companies. However, Finns are working in an open environment which means that they can communicate with their boss directly and are empowered to get the job done. That is also a reason why they can have creative ways of solving problems.

4.3 Chinese culture overview

China, officially called People's Republic of China, is a sovereign state located in East Asia. China has the largest population of 1.3 billion people in the world. Mandarin is the official language in China. China is the third largest country by total area after Russia and Canada with approximately 9,600,000 km². China has administrative control over 22 provinces currently and has 56 ethnic groups. As of 2013, China has the world's second largest economy in terms of nominal gross domestic product (GDP) totalling approximately US \$ 8.250 trillion according to the International Monetary Fund/9/. China is a member of WTO and is the world's largest trading power with a total international trade value of US \$ 3.87 trillion in 2012/10/. As of 2007, there were 396,567 primary schools, 94,116 secondary schools and 2,236 higher education institutions in China./11/

The ratio of university graduates in the whole population becomes higher and higher as time passes. But in contrast to Finland, there is a tuition fee for higher education.

4.4 Chinese business communication style

There is a proverb in China: The unique features of a local environment always give special characteristics to its inhabitants. As China is huge and its climate and topography vary from place to place so do the inhabitants. But all Chinese people are afraid of “losing face”. Causing someone to “lose face” can result in serious consequences for business interactions and even loss of business. Mastering some techniques to be able to “give face” and help your Chinese partner “save face” when he or she is “losing face” can be a vital asset in doing business successfully. Unlike in most western countries, Chinese people are indirect. They tend to speak in a roundabout style rather than getting directly to the point. When communicating, the Chinese focus on relationships which mean that they are more people-oriented than task-oriented. Relationship-focused people prefer to do business with family, friends, acquaintances or other people they already know well. In China, particularly the more trusted people you know, the more easily you can get things done. Of course, it also depends on who you know, which means that finding the right person is extremely important. When conducting a business meeting, try to address a person using his or her family name only, such as Mr Chen or Ms Chen. Avoid using his or her given name unless you have known him or her for a long period of time. Formality is a sign of respect. Unlike in western countries, in China it is assumed that the first person that enters the room is the head of the group. When exchanging business cards, hold your card using both hands, the writing faces the recipient. Never toss your business card across the table which is extremely rude. The Chinese have a reputation for 'impassiveness' and this is largely based on a Western misinterpretation of Chinese body language. As with the Japanese, the Chinese use a very limited amount of visual body language and Westerners interpret this rigidity as a lack of responsiveness and emotion. Lack of overt body language does not mean that the Chinese do not show their reactions – it is more that Westerners are not skilled at reading them across the cultural divide. For example, it is common that Finns keep silent but in China it will make people uncomfortable. The Chinese dislike being touched by strangers. Do not hug and make any body contact when you first meet. Unlike western companies, Chinese companies have a hierarchical organization structure where the top leader steers the company direction. It is a top-down communication from top decision makers to employees, which means that only the top executives are making

decisions regarding any project and workers follow the order, implement the plan, monitor the process and report to the leader.

5 Products and outsourcing criteria

When a product is launched on the market, it will have its own life cycle. Knowing the product life can help companies to develop and manufacture their products to fit the market. When it comes to outsourcing, especially electronic products, electronic manufacturing service (EMS) plays an important role in outsourcing. In this chapter, the product life cycle will be briefly introduced and EMS will also be introduced as well as how to select a proper EMS provider.

5.1 Product life cycle

Product life cycle is the stages through which a product or its category passes/12/. There are four stages in a product's life cycle:

- Introduction
- Growth
- Maturity
- Decline

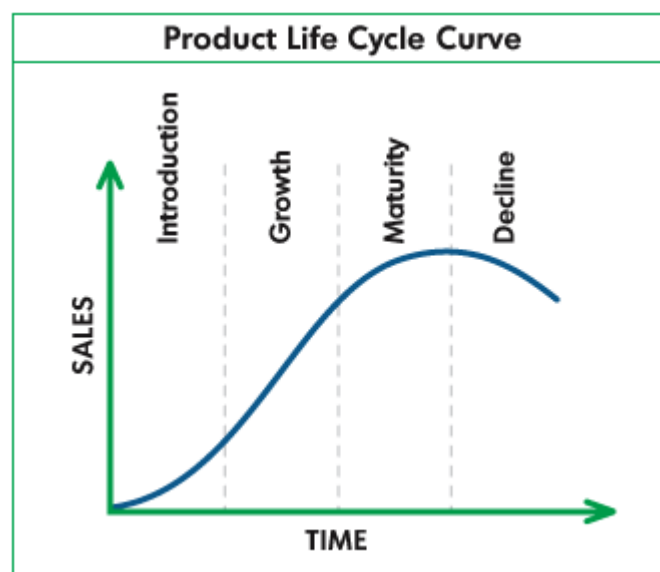


Figure 3. Product life cycle/13/

Stage 1: Introduction

New products are introduced to meet the customers' needs and new products are first exported to similar countries with similar needs, preferences and incomes.

Stage 2: Growth

A copy product is produced elsewhere and introduced in the home country to capture growth in the home market. Usually production is moved to other countries due to production costs.

Stage 3: Maturity

At the maturity stage, sales growth has started to slow down and is approaching the point where the inevitable decline will begin.

Stage 4: Decline

This occurs when the product peaks in the maturity stage and then begins a downward slide in sales.

5.2 Electronic manufacturing services (EMS)

Electronic manufacturing services (EMS) is a term used for companies that provide tests, manufacture, distribute and provide return or repair services for electronic components and assemblies for original equipment manufacturers.¹⁴ EMS emerged after late 1970s, and its use has grown extraordinarily since 2006.

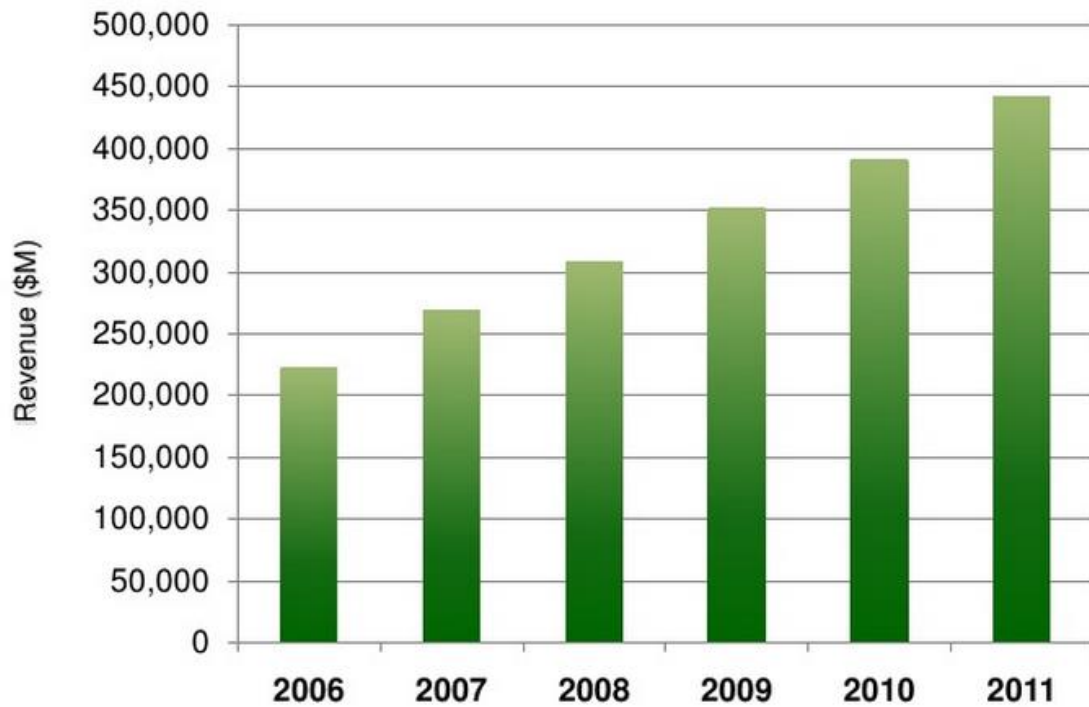


Figure 4. Worldwide EMS Market/15/

An original equipment manufacturer (OEM) usually manufactures products or components that are purchased by another company and customizes the designs based on the reseller. OEMs spend billions of dollars annually on outsourcing electronics production. Choosing the wrong supplier can result in significant cost increases, poor product quality and insufficient customer relationship issues. Since the EMS plays a significant role in a successful business, the companies focus on choosing a good EMS partner. For a company who seeks a good EMS partner, here are some suggestions to evaluate:

- Evaluate supplies on the key process capabilities
- Administrative processes — what are the supplier’s order processing, purchasing practices, production planning, communication process?
Capabilities and capacity — does the supplier meet your current production and growth production, quality and technology requirements?
- Engineering change order management — can the supplier adequately accommodate your design changes and improvements and balance all the manufacturing processes to meet those needs?
- Communication, customer service, on-time delivery — is the supplier responsive to your everyday needs and what are the supplier’s processes that accommodate this requirement?
- New product introduction capabilities

- Domestic and offshore capabilities
- Design, prototype, documentation, process development, and transition plan to production support
- Resource planning system
- A closed-loop system that quickly identifies misalignment and initiates action to correct material and production bottlenecks upon discovery plus incorporates a communications system that notifies the OEM(original electronic manufacture)
A system that identifies production gaps and balances supply with demand
- Excess and obsolescence — end of life material process
End of life/ life cycle planning is critical to supporting existing production revisions while the new versions are being implemented to ensure production flow remains steady for both companies

In other words, companies should make their decisions according to the total cost. Companies also need to look for a long-term partnership rather than a short-term price. Finland is a medium-sized market in the EU, and Finnish production accounted for about 5-10 % of the total EU EMS production in 2008.

6 Product quality

Quality from the consumer's perspective is that the product should be designed and produced to meet the consumer's quality expectation. The dimensions of quality primarily for manufactured products that a consumer looks for in a product include the following:

- Performance: the basic operating characteristics of a product
- Features: the “extra” items added to the basic features
- Reliability: the probability that a product will operate properly within an expected time frame
- Conformance: the degree to which a product meets re-established standards
- Durability: How long the product lasts; its life span before replacement
- Serviceability: the ease of getting repairs, the speed of repairs, and the courtesy and competence of the repair person
- Aesthetics: how a product looks, feels, sounds, smells or tastes
- Safety: assurance that the customer will not suffer injury or harm from a product

- Other perceptions: subjective perception based on brand name, advertising and the like/16/

From the producer's perspective, quality of conformance is to make sure that the product is produced according to design. Design, material and equipment, training supervision and control are factors included to achieve quality of conformance. From a producer's view, an acceptable cost to achieving quality of conformance is a very important consideration. If the products cannot be produced at a cost that is lower than the price that the consumer is willing to pay given the product's quality characteristic, the final product cannot be accepted.

Both the consumer's and the producer's perspective of quality, can be illustrated by the following graph:

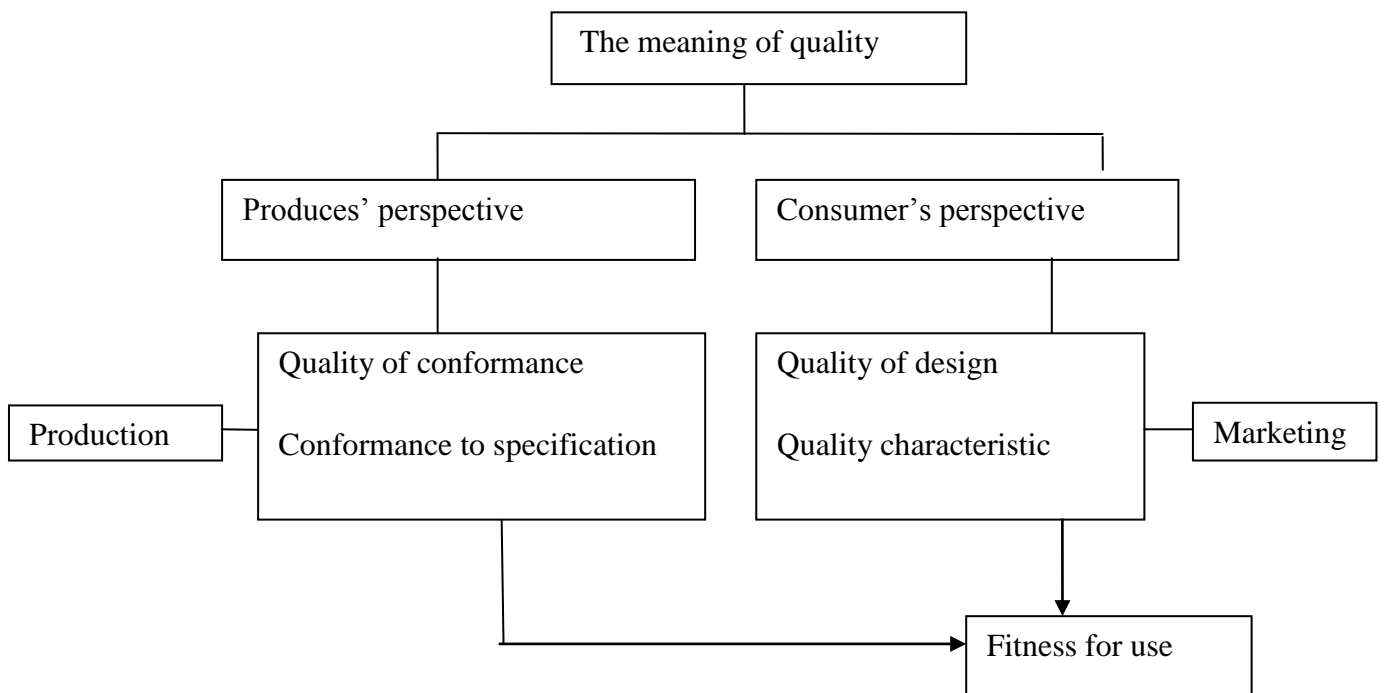


Figure 5. Meaning of quality /17/

6.1 The manufacturer's quality control

During manufacture, there may be some quality problems. In order to analyse and identify the problems, there are several quality control tools:

- A pareto analysis can be used for identifying the cause of poor quality. The pareto analysis uses a diagram for tallying the percentage of defects resulting from different causes to identify major quality problems/18/.
- A flowchart is a diagram of a job operation or a process. The flowcharts present quality problems to get a clear picture of a specific operation and a common frame of reference/19/.
- Numbers of quality defects can be listed in a check sheet/20/.
- A histogram is the total tally of defects for each cause/21/.
- A scatter diagram is using a graph to display the relationship between two variables in a process/22/.
- A cause-and-effect diagram is a graph of the causes of a quality problem divided into categories/23/.
- The statistical process control chart has statistical upper and lower limits. If the process stays between the limits over time, it is under control and problems do not occur. Control charts establish the control limit of a process. The p-chart and c chart has the variables \bar{x} and \bar{R} . A process is considered to be in control if there are no samples points outside the control limit, most points are near the process average without too many close to the control limits, approximately equal numbers of sample points occur above and below the centre line, or the points appear to be randomly distributed around the centre line. There are two kinds of control charts to use, one is the p-chart and the other is the c-chart. The proportion of defects in a sample is used in the p-chart. Figure 6 can give you an overview of a control chart.
/24/

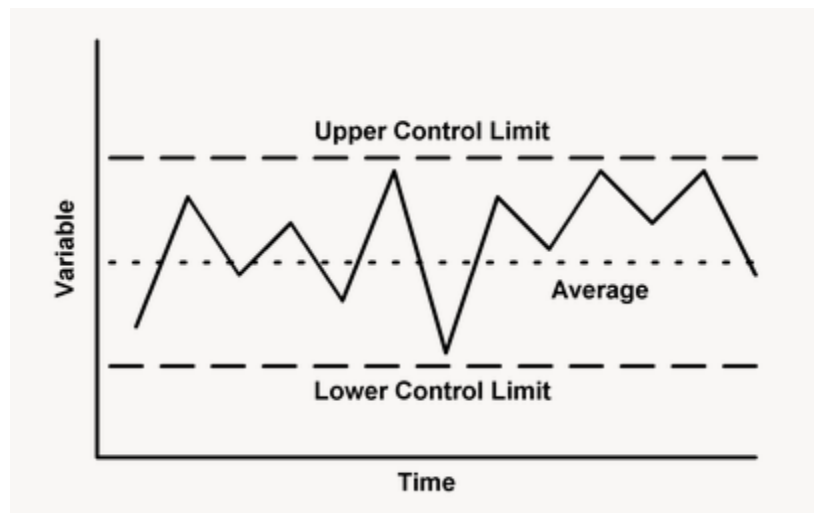


Figure 6. Control chart

From the manufacturers' perspective, the most important thing is to locate problems and solve them. Choosing one kind of control tool can provide consequent improvement action and can offer better sales service.

6.2 The customer's quality control

From the customer's point of view, knowing the product quality when you have not ordered the product is a big issue. Factory audits are a kind of standard service offered by quality control agencies. Typically they are used by a buyer who wants to evaluate a manufacturer before they start a business relationship. In order to evaluate the product quality during manufacturing, a factory audit is a good way to see what the factory and the quality are like. The following aspects of a manufacturer's operation can be evaluated:

- Reliability (Is there a good quality management system?)
- Process (how well do they perform certain key processes?)
- Capacity (how many pieces can they produce in a day?)
- Workplace conditions (do they respect the local law and some international standards?)

A well-documented control plan is the basis of every audit. There are two types of quality control plans, one is the quality control plan including a contract with the Chinese supplier and the other is the quality control plan that is used in production in each process step.

Another way to control the quality is inspection. An inspection is an organized examination or a formal evaluation exercise. There are four types of quality inspections used to inspect the product:

- A pre-production inspection tells the buyer which kind of raw materials will be used and whether factories are suspected of lowering their costs by purchasing substandard materials. The pre-production inspection can also focus on the processes followed as production starts.
- A during production inspection allows the buyer to get an idea of the average product quality early in the production cycle. But if quality issues are found, what is already produced might be re-workable and corrective actions should be taken for the rest of the job. It will avoid delays for buyers.
- The final random inspection is by far the most common type of quality control check. It takes place once 100 % of the shipment quantity is finished and at least 80% is packed. It puts pressure on suppliers and gives power to buyers. It aims to confirm a shipment's quality.
- The container loading inspection which is seldom used can be a worthwhile option in some specific cases.

Sampling inspection involves all types of inspection which inspect a relatively small number of items from a batch or a lot and then using the results of this sample to either accept or reject the entire lot. Sampling inspection relies on statistical probability and the term acceptable quality level (AQL) is used in sampling inspection. It is the maximum percentage of defective products that is acceptable as a long-term average.

7 Outsourcing of electronic products

As mentioned in chapter 5, what the company needs and wants should be clearly analyzed before seeking EMS providers? So in this chapter, the company-specified requirements will be analysed. Meanwhile, the EMS providers should be looking for the confirmed requirements. How to seek an EMS provider will be explained in this chapter. Efficient communication related to production and products between the EMS provider and the company plays an important role. The criteria which should be taken into account during communication will also be discussed.

7.1 Company requirements

The outsourced electronic products are Printed Circuit Boards (PCBs). A printed circuit board is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched in copper sheet laminated onto a non-conductive substrate. The multilayer PCB is made up by two or more PCBs which are stacked together with a reliable predefined mutual connection between them. In Comsel System Ltd, the products of smart meters use multilayer PCBs to meet the requirements. The cost of a low-volume PCB production in China is lower than the cost in Finland. The quantity demand of multilayer PCBs is low which means that a suitable EMS company which can offer the low-volume multilayer PCBs at a low price with a high quality is required. The specific requirement should be defined by the company manager. In general, the EMS provider should have the ability to provide multilayer PCBs at a low price with a good quality.

7.2 EMS providers

The product requirements are confirmed and then the next step is to seek suitable EMS providers. Nowadays, almost every EMS company has its own website to display their products. What is more, different EMS companies have different quantity requirements such as low volume, medium volume and high volume. The outsourced company's specialized products, the company's size, the product lead time, the logistics, the company's organization structure, technology and quality level should be taken into account when searching for an EMS provider. With the rapid development of Chinese E-business, the most efficient way to search for the EMS provider is to search on websites. In China the most popular and convenient website is alibaba.com which provides the company information and also you can send quotations to the companies. As mentioned in chapter 3, China forms relatively complete electronics industry communities by Yangtze River, Pearl River and Bohai. Every big brand company in all of the Industrial Park is surrounded by numerous small and medium-sized manufacturers. And logistics in those areas are convenient and their supply chain is powerful, fast and integrated. Considering those advantages, seeking EMS providers in those areas might be a good choice. Search for at least ten companies including one big-sized company, two medium-sized companies and other small-sized companies in those areas. The reason why you need a big-sized company is that the big companies usually have the advanced technology and equipment which can

be compared with the technology and equipment of the medium-sized companies and small-sized companies. Usually the big company's size is over 2,000 people, and medium-sized companies are about 300-2,000 people and small companies are about 50-300 people.

7.3 Communication with the EMS provider

After having basic information about EMS providers, efficient communication turns out to be very important. When it comes to communication with EMS providers, you usually communicate with EMS provider sales. The first step is to consult the basic information about the EMS providers related to the production and products. Appendix 1 is a table which contains the basic information about the EMS providers. Despite basic company information such as name and size, production, test, production lead time and delivery method it is important to assess a company whether the supplier company meets the requirements of the outsourcing company. Production equipment and production step are related to processing quality. Which kind of equipment was used and what the steps are are signs of technology and skills in company. Test equipment and types of test are related to acceptance quality. As for production lead time and delivery method and time, the sum of both is the product lead time. If the delivery and the production lead time are shorter, the market response will be faster. Service support and a list of improvement reports are important after the sales part and are part of product quality. The price can be divided into two parts. One is the product price and the other part is the logistics price.

As mentioned in the Chinese business communication culture chapter, Chinese companies have a hierarchical organization structure where the top leader steers the company direction. The most important thing is to find the right person to communicate with. The company organization structure shows who is in charge of the project. Under most circumstances, the people who communicate with you are people in the sales department. At the same time, the attitude of the sales department towards products should be taken into account in the service assessment.

8 Analysis

On the basis of the table in appendix 1, each company's basic and professional information can be analyzed. When choosing an EMS, professionalism, timeliness and results determine company whether a supplier company meets the outsourcing company's

expectations. In this chapter, the basic information about a company, key process capabilities, product lead time, service support and price will be analyzed.

8.1 Companies' basic information analysis

The company size and the company-specific products can be seen in the appendix 1 table. Since the required PCBs are multi-layered PCBs, it means that the EMS provider should have the ability to provide multilayer PCBs. If the EMS provider focuses on company's multilayer products, it can be better to choose this provider. The production capacity is not so high in the beginning when the products are introduced to the market. But as the product life cycle goes to the growth stage, the production capacity also grows faster. That means the EMS provider's production capacity needs to meet the desired production capacity. Also the ability of producing prototyping is necessary according to the product life cycle stage 1: new products are introduced to meet the customer's needs. All prototype builds receive a comprehensive manufacturability report which includes observations during the build and final recommendations for improvement of both manufacturability and quality. Therefore, the ability of providing a prototype report is vital. EMS companies must provide certificates to show that their products meet EU requirements both regarding the process and the environmental issues. The Restriction of Hazardous Substances Directive (Rosh) requirement is compulsory for electronic products. Lead cannot be used in PCB production even though it can improve the quality of PCBs.

8.2 Key process capabilities

During PCB manufacturing, the producing equipment, producing steps, test equipments as well as the types of tests are key processes. Producing equipment gives an overview of the company producing technology. Since each company has their own producing equipment, compare each company's equipment and get a general idea of which kind of equipment might be used by the majority. Producing steps in each company production can measure the resource planning system. Also the process steps and machinery must be in accordance with the customer's order. Test equipment and types of tests illustrate which kind of test will be done, a functional test or a physical test. The test will have to meet the requirements of company products and it will have to be efficient.

8.3 Product lead time

A product lead time is the period between a customer's order and delivery of the final product. In the appendix table, manufacture processing lead time and delivery time consist of product lead time. The five major methods of transportation are railroads, trucking, water, air and pipelines. Air transport is quite quick but very expensive. So volume production is not suitable for it. Considering the distance, volume of production, convenience of transportation as well as prices, sea transport is the best choice. But delivery by sea takes almost 5-6 weeks and every EMS company has the same situation. However, the processing lead time in different companies is different. For every product, the shorter the processing lead time is, the better the market will respond. In a word, the shorter the products lead time, the better the EMS provider.

8.4 Service support and price

The service support is a vital aspect of assessing the products and long term cooperation. What is more, the improvements of production reports are also a key to assess long-term cooperation. The quality related to the service they can provide is the service offered by the manufacturer to scale the assembly production (see the appendix 2) /25/. The after sales service can also be supported by EMS. The price is quite important when choosing an EMS provider. The prototype price and the production price are different. When starting to manufacture, the bill of material (BOM) and PADS and the designed PCB file (Gerber file) should be sent to EMS. Before sending the file, the contract of secrecy should be signed to protect copyright. The price should also include the transportation price and every company will give their prototype price and volume production. Usually, the price also depends on the volume and sometimes it will be negotiated. Showing your sincerity and long term cooperation ability to the proper EMS will produce a win-win situation.

9 Result

The aim of this thesis was to find outsourcing companies which can provide PCB products with a good quality and price. Finding a proper EMS provider and ensuring product quality was the main purpose of this thesis. Therefore, choosing a proper EMS provider and ensuring the product quality were central questions. To look for a suitable EMS provider and good quality products, basic information about the company, about processing

procedure, processing equipment, types of tests, product lead time and service are gathered. Usually, company information is had from the EMS providers' sales department. Patience and the possibility of a long cooperation should be shown.

Using a comparative approach to analytic research, advantages and disadvantages of each company can be analyzed and a proper EMS provider can be chosen to build a long-term cooperation.

The result was that an EMS company size of 50-300 employees is suitable. The specialized products should be about 2-20 layer PCBs. It does not mean that the specialized products with more than 20 layers are not good but the specialized products of about 2-20 layers are suitable. Certainly, the products should be without lead (it is a chemical element in the carbon group with the symbol Pb) which is not allowed in PCBs. And production capacity should match company products' growth. As we all know, time is money especially for new products. The shorter the product leads time, the faster the market responds. What is more, the price is very important when choosing a partner. The price should be proper, neither too high nor too low considering a long-term cooperation. The service is one of the important aspects which should include technical support and improvement result. By taking into account company size, specialized company products, product lead time, price and service, choosing a proper EMS for Comsel System Ltd can be achieved.

10 Conclusion

This thesis briefly gives an introduction to how to outsource in China and how to ensure the electric products' quality. Nowadays, the production of low-volume electronic products in China is cheaper than in Finland. Electronic products in China have a rapid growth and China has a good business environment for exporting electronic products. Choosing a proper EMS partner is definitely important for a Finnish company.

Company information is not easy to get before you order their products. Be patient with company sales and explain company requirements in detail. Sincerity should be shown to them and a long-term cooperation desire is also needed. To protect the commercial private copyright, signing the commercial guaranty seems necessary. A Chinese company is totally different from a Finnish company. Finding the right person to talk to makes the project go smoothly. Since the Chinese company has a hierarchical organization structure and a top-

down communication style, workers just report faults to their director. It is more efficient to communicate with the project manager than with workers.

In order to choose a proper EMS partner and build a long-term cooperation relationship, quantification of company information should be assessed. The company size and companies' production capacity can be explained by figures. From those figures, get basic information about the company. Filter those companies which are not suitable. Then compare the production process equipments, steps, along with test equipments and types in each company, choosing the more advanced technology and accurate test equipment. As for the price, choose the proper price instead of the lowest price. Company size, production capacity, processing lead time, logistic time and price can be assessed by figures. Furthermore, the service of products can be also assessed by the attitude of the sales department.

Efficient communication between two companies is the key to success. Even though I know both cultures, I met some problems during communication. The way people think is totally different. I would suggest that if anyone wants to cooperate with a Chinese company, try to be patient and make requirements very clear.

In this project, due to the limited number of EMS companies and due to the fact that we have not been able to check the companies in any greater detail before ordering products, only a few possibilities were left for further studies. A few steps can be implemented to make a more accurate decision when choosing the EMS provider and ensuring good quality, namely the following:

1. Gather more information about EMS companies
2. Commit a line audit in EMS companies before order
3. Do an inspection and determine the AQL for each EMS provider

If those steps can be implemented, the company can establish a good relationship with the EMS provider.

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Appendices

Appendix 1

	A	B	C	D	E	F	G	H
1	company	company	company	specified	production			
2	name	organization	size	layers	capacity	prototyping	report	certification
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
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14								
15								
16								
17								
18								
19								
20								
21								
22								
23								

A	B	C	D	E	F	G	H	I	J
producing equipment	producings steps	test equipment	types of test	test standard	production lead time(working day)	delivery method and time(working	list of improvement report	service support	price

Appendix 2

Manufacturing service assessment

Designators			Remarks
A	Component Procurement	<input type="checkbox"/> Consignment <input type="checkbox"/> Passive Thru-Hole <input type="checkbox"/> Passive SMT <input type="checkbox"/> I/C SMT <input type="checkbox"/> Hi-Pin Count (Peripheral) <input type="checkbox"/> Hi-Pin Count (Array) <input type="checkbox"/> Other:	
B	Board Procurement	<input type="checkbox"/> Consignment <input type="checkbox"/> Single Sided <input type="checkbox"/> Double Sided <input type="checkbox"/> Multilayer (Rigid) <input type="checkbox"/> Multilayer (Rigid-Flex) <input type="checkbox"/> Metal Core Boards <input type="checkbox"/> Other:	
C	Design Services	<input type="checkbox"/> Outsource <input type="checkbox"/> Simulation <input type="checkbox"/> Circuit Analysis <input type="checkbox"/> Placement & Routing <input type="checkbox"/> Design Rule Implementation <input type="checkbox"/> Impedance Control <input type="checkbox"/> High Speed <input type="checkbox"/> Other:	