# 國立政治大學商學院國際經營管理英語碩士學位學程

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碩士論文

Master's Thesis

# 替換零件及耗材之實務商務行銷計畫和需求預估模式

**Practical Business Approaches with a Simple Forecasting Model for Aftermarket Replacement Parts**

Student: Timothy Yau Tsz Him

Advisor: Professor Chester Ho

中華民國一百年六月

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## Abstract

The main aim of this thesis is to develop a framework that allows an equipment manufacturer to forecast the demand of its aftermarket user-replaceable parts and prepare the challenges it may face from third party manufacturers. Some business practices ensuring the performance against third party part manufacturers are suggested in this thesis as a reference for a manufacturer to retain its customer and optimize its performance in aftermarket.

The first part of this thesis focuses on the framework of a forecasting model for an equipment manufacturer which needs to provide aftermarket consumers to end users through the service or sales channels of the manufacturer. The forecasting model is carried out using the data from annual sales quantity of one model of equipments(known as install base) during the product life cycle. Each year during the product life cycle would have a different Rate of Replacement. The forecasting model aggregates the data from the install base and the rate of replacement to come up with an annual demand of the aftermarket replacement parts needed for the equipment.

The second part of this thesis focuses on some practical business practices for the manufacture to ensure its performance in aftermarket. The designs of the products, logistics arrangement and selection of channels are also curial to its performance.

## Acknowledgements

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# 1. Introduction

In many industries, price would be the top priority for a user to consider. In aftermarket replacement parts, however, this is not the case. The study by Rochester Institute of Technology[1] shows that Delivery (Availability) is the most important factor when an end user makes the purchase. In other words, who has the parts in stock can probably get the business.

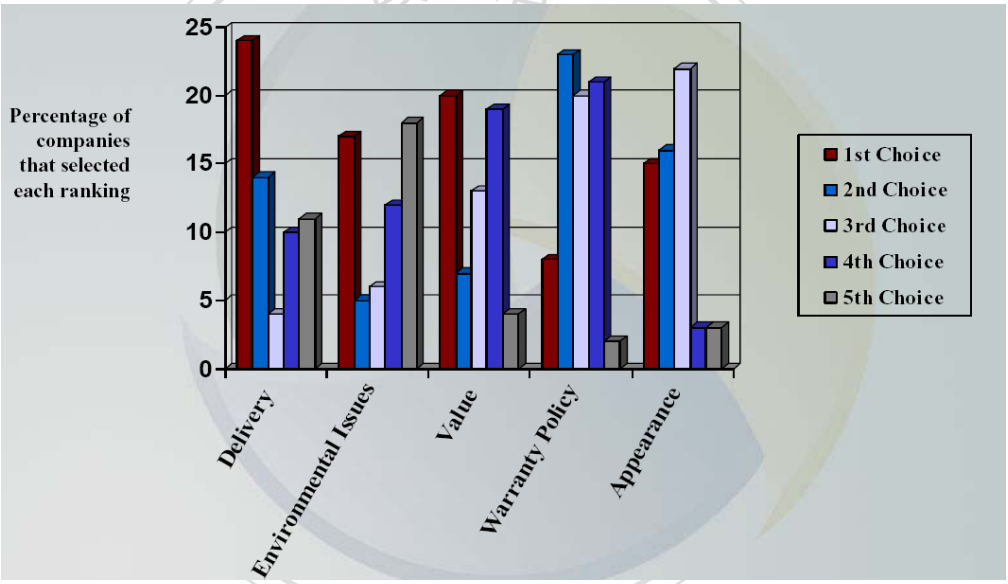


**Figure 1.1 Ranking of issues that are important to customers**

## 1.1 Current Situation of Aftermarket

The Porter's Five Forces is an illustrative tool to depict the whole pictures in aftermarket replacement parts. This is very important analysis to find out the force(s) needed to address in this study. Figure 1.2 shows the intensity of the forces in the Porter's Five Forces analysis.

**i. Force from Rivalry Among Existing Firms :**

- Only original manufacturers can produce the exact original parts in aftermarket. Therefore, there is no direct rivalry in aftermarket replacement parts. Those parts manufactured by third party manufacturers are classified as “Substitutes” as they are not considered as the same product offered by the OEM manufacturers.

**ii. Buyer’s Force :**

- End users are generally not knowledgeable about the products they are purchasing. Normally, end users would only consider the price when they are buying a consumable product. Therefore, they constitute a relative strong force.

**iii. Supplier’s Force :**

- There are a lot of companies can provide raw materials to the original manufacturers to produce the parts. Therefore, the bargaining power in suppliers is very weak. However, for some key components, normally the original equipment manufacturers would have agreements with suppliers in order to build up a higher entry barrier for third party manufacturers. The suppliers are then bound to original manufacturers. In this case, this would result in a slightly stronger force. However, in recent trends, suppliers are starting to offer the key

components to the “substitutes” force in order to gain more bargaining power when facing original equipment manufacturers.

**iv. Force from Threats of New Entrants :**

- “New entrants” refers to new machines sold in aftermarket replacement parts. This is not applicable and out of scope in our study.

**v. Force from Threats of Substitutes :**

- Threats of Substitutes pose the strongest force in the Porter’s Five Forces analysis. As a result, this thesis focuses mainly on the study of this force. As explained in Buyer’s force above, end users are not technically-savvy to identify the parts they purchase. Therefore, this creates an opportunity for third party manufacturers to take a certain portion of the market. Also, the large price gap between the OEM parts or copy parts may also result in stronger force in this aspect.

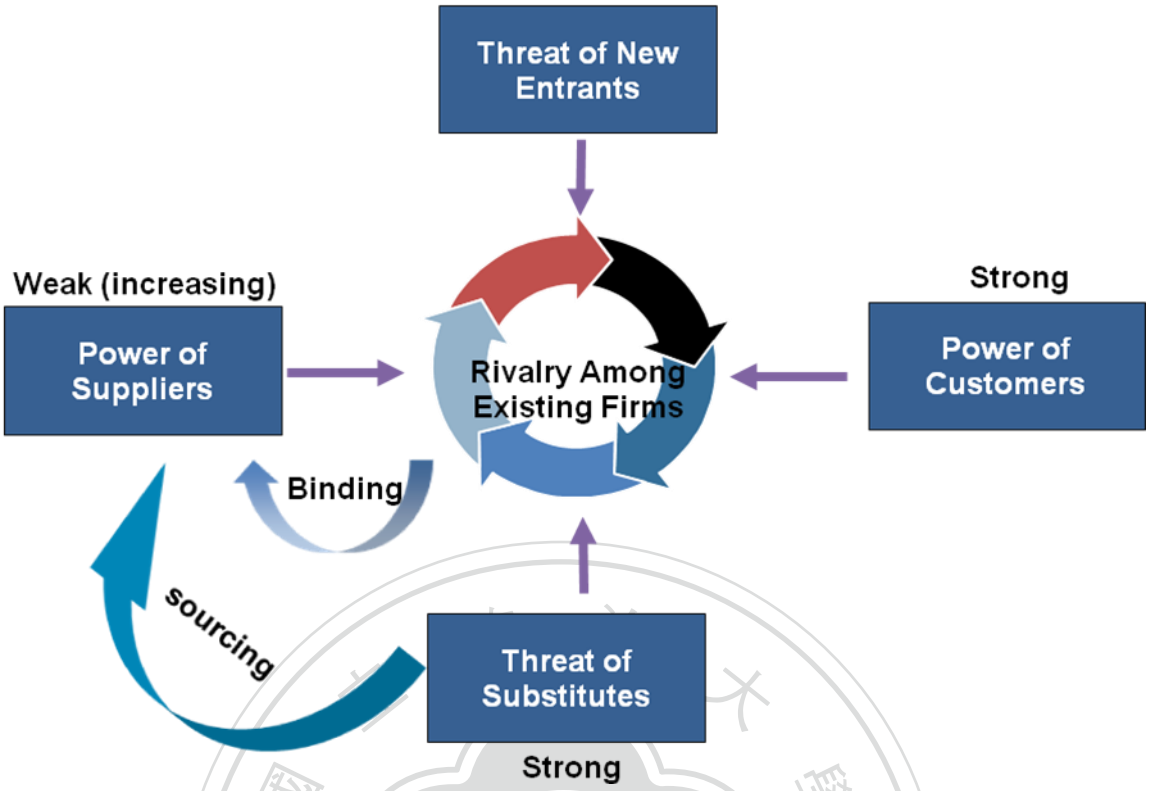


**Figure 1.2 Porter's Five Forces Analysis in Aftermarket Replacement Parts**

### 1.1.1 Lack of Awareness

According to Capemini Consulting Group [2], most companies do not prepare sufficient investment in the aftermarket, therefore their performance in aftermarket does not meet the expected result. Figure 1.3 shows a survey result of automobile company preparedness in aftermarket. Quoted from the report of the Capemini Consulting Group, "To really be successful in the aftermarket, companies' investments need to be drastically increased.". Apparently, the equipment manufacturers do not really care about the aftermarket, allowing those copy manufacturers to take over certain portion of the market share.

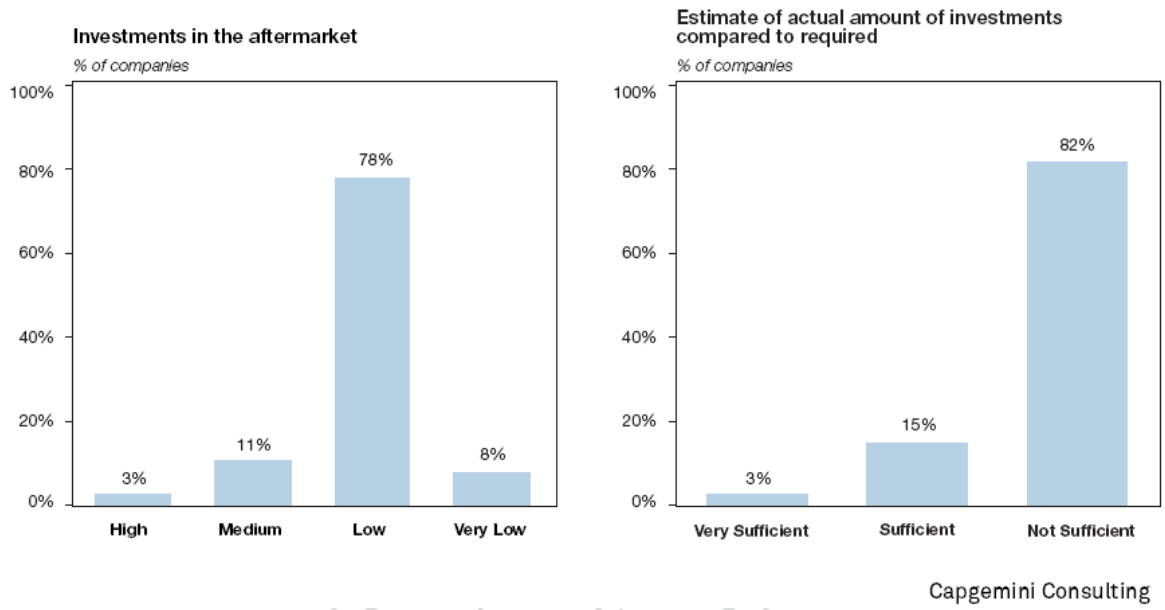


**Figure 1.3 Investments in the Aftermarket and Evaluation of the Investments**

### 1.1.2 Parts availability before End Of Service (EOS)

Secondly, normally the product life cycle of a product ranges between few months and few years before it comes to End Of Life (EOL). However, equipment manufacturers have to provide aftermarket parts for the machines before it comes to End Of Services (EOS). There would be enormous inventory they have to keep in order to serve their customers. This makes it very costly and this would always result in shortage of parts. When the end users encounter a shortage of replacement parts they need, they are forced to adopt other solutions whatever available in order to keep the machine working.

### 1.1.3 Lack Of Service Innovations

Lack of service innovations is also a result of low preparedness and readiness for the aftermarket. Manufacturers usually disregard the local requirement of service level. Therefore, it always results in decreasing customer satisfaction in the aftermarket. Some manufacturers may presume that they can sell replacement parts through the point of sales where the users purchase the machine. Actually, there are several options of channels so they can expand the accessibility of those user-replaceable parts.

### 1.1.4 Competition from 3rd Party Manufacturers

It is a normal practice for an original manufacture to sell a machine at a competitive price to gain market share or install base and make profit by selling replacement parts. This is a well known practice especially in printer / printer cartridge. The original manufacturer normally sets a high price for those aftermarket replacement parts. This high margin business practice encourages 3rd party manufacturers to get into the market by offering much cheaper price than how much the original manufacturer would charge. The machine users are allured to purchase a replacement part from 3rd party manufacturer because of the huge price gap between original parts and non-original parts.

## 1.2 Common Terminology

### 1.2.1 Copy Manufacturer / Third Party Manufacturer

Copy Manufacturer / Third Party Manufacturer who is not the original manufacturer of the equipment imitates the original (OEM) parts by doing reverse engineering. The parts manufactured by third party manufacturers are also called “copy parts”, “compatible parts” or “aftermarket parts”.

### 1.2.2 Aftermarket

Aftermarket refers to any market where the customers who implement one product or service are likely to purchase a related, follow-on product. [3]

### 1.2.3 Reverse Engineering

Reverse engineering is taking apart an object to see how it works in order to duplicate or enhance the object. The practice, taken from older industries, is now frequently used on computer hardware and software.

### 1.2.4 Install Base

Install base is a measure of the number of units of a particular type of equipment actually in use, as opposed to market share, which only reflects sales over a particular period. Because

install base includes machines that may have been in use for many years, it is usually a higher figure than market share. Install base is not the same as the total number of units sold at any given moment in time (cumulative sales numbers), since some of those units will typically be out of use because they have broken, gone missing or been made obsolete. [4]

### 1.2.5 End Of Life (EOL)

Every product has its product life cycle. The manufacturer will announce the End Of Life(EOL) of one product when it is going to discontinue the production of the equipment or machine. After the announcement, the product is no longer in mass production status. However, the manufacturer would keep providing the aftermarket or service parts to serve the customers who purchased the product.

### 1.2.6 End Of Service (EOS)

When it comes to End Of Service(EOS), the manufacturer will discontinue the production of all the aftermarket parts associating with the product. Normally the manufacture will announce End Of Service(EOS) after a certain period it announces the End Of Life(EOL) of the product.

### 1.2.7 Original Parts or OEM Parts

Original Parts or OEM Parts are the parts manufactured by original manufacturer of the machine. Parts manufactured by Original Design Manufacturers(ODMs) should also be considered as Original Parts or OEM Parts.

## 2. Applicable Industries

The scope of this thesis would only address replacement parts that are consumables of one product. Only parts can be consumed over the usage time of the products would be the interest of this thesis. In addition, this thesis would only address user-replaceable parts. Parts that are not user-friendly for a user to replace would also not be the interested of this thesis.

### 2.1 Automobile Business

There are millions parts in an automobile. However, not all of these parts are consumable products. The head light of a car is the most common replacement parts that a user need to replace when it comes to the life. The business in replacement parts in Automobile industry represents a considerable portion of profits in terms of the profitability of the car manufacturer as a whole. The aftermarket business accounted for about half of the profits of European automotive OEMs in 2007. [5] According to Automotive News Magazine (U.S.), the market size of part the global output value of automobile components would be US$742.8 Billions. The market size of LED headlights is worth US$1.2 billion. In old days, those High Intension Discharge (HID) headlights could just last for 3,000 to 4,000 hours. Now the present LED headlights can last over 50,000 to 100,000 hours which hardly give an opportunity to 3rd party manufacturers to sell a second bulb.

## 2.2 Printer Business

A printer cartridge is the most well-known consumable in printer. There are laser-jet printers and inkjet printers, both of which need a replacement cartridge when it comes to life. In additions to cartridges, drums are also a consumable / replacement parts in some models of printers. But drums may not be user-replaceable in some machines. For example, in Epson printers, an end user is required to replace the cartridge of the laser-jet when it comes to 25-39 PPM. There are numerous 3rd part manufacturer producing printer cartridges. These manufacturers already represent 30% of the aftermarket in USA and Canada in 2004 [6].

## 2.3 Projector Business

A projector lamp is equipped in every business and educational projector. The lamp normally comes with a life time, which ranges from 2,000 hours to 4,000 hours depending on the wattage of the lamp [7]. The market size of projector lamp is estimated 3 million units in 2010, according to IDC [7]. It is expected to increase from 2004 as the install base of projectors was increasing the past few years. With an average selling price of over $200 per unit, the market size of projector lamp is at decent level, amounting to over 600 million US dollars.

## 2.4 Rear Projection TV Business

Similar to projector, a rear projection TV, also known as RP-TV, also uses a consumable lamp inside the machine. The install base of RP-TV was huge in United States. The wattage of the lamp normally ranges from 100W to 150W. As the wattage is lower, the lamp can last longer than a projector lamp. The normal life span of a RP-TV lamp is 4,000 hours to 6,000 hours. However, due to the plummeting price of flat panels, people no longer want to purchase replacement lamps for an old TV. However, there were still 200,000 units of RP-TV sold in 2009, a sharp drop from 2,500,000 units in 2006. [8]

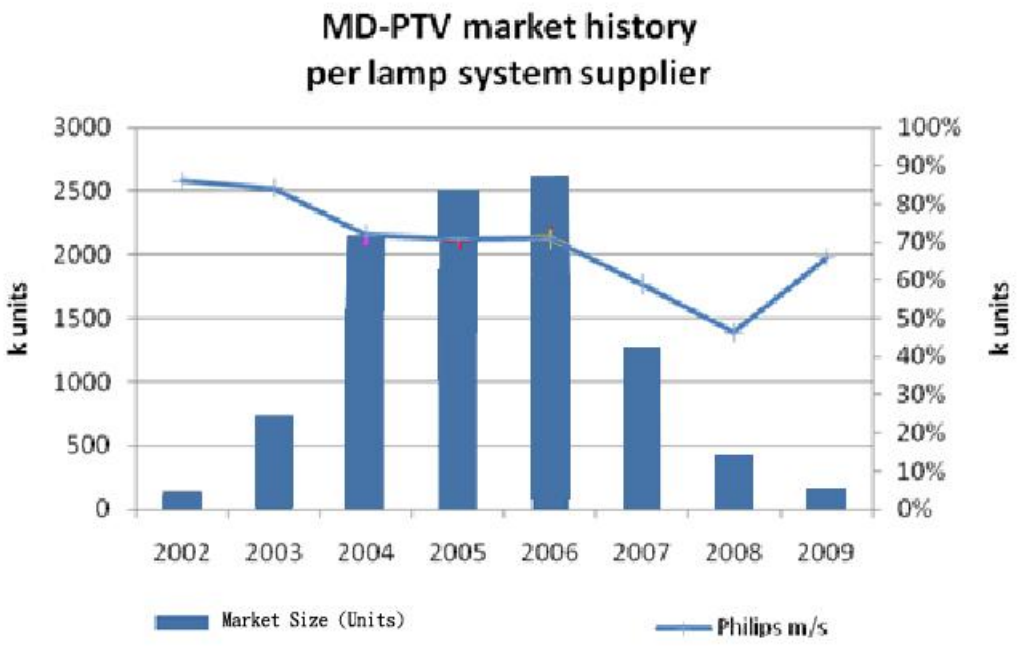


**Figure 2.1 Units of Rear Projection Television shipped from 2003 to 2009**

| | Automobile | Printer [2] | Projector [1] | RPTVs |
|---|---|---|---|---|
| Estimated Market Size in 2011 | US$1.2 Billion[9] | US$45 Billion | US$600 Millions | US$120 Millions |
| Average Life Time | 5,000~10,000 hours | 1000 pages[3] | 2000 – 6000 hours | 4000 – 6000 hours |
| Market Share of Compatible | 10-20% | 30%[6] | 20-30% | 40% |
| Replacing Technologies | LED Headlight | Electronic Paper | LED / Laser Hybrid | Plasma / Flat Panel |

**Table 2.1 Summary of Applicable Industries**

[1] Projector Lamp only

[2] Printer Supplies including cartridges and ribbons

[3] Canon Genuine Ink-jet Cartridge

## 3. The Framework of the Forecasting Model

Consumers cannot wait few weeks for the delivery of the replacement part if the machine is out of order. Therefore, availability in aftermarket is very important. To make sure replacement parts can be available as soon as a machine user needs it, an accurate forecast is paramount important. In the forecast model proposed in this thesis, there are 3 main factors taken into consideration when doing the forecast.

## 3.1 Forecasting Factors

### i. Install Base

It is the cumulative number of units sold of one machine model. Theoretically, install base should exclude the number of units being obsolete. However, this number cannot be estimated so no obsolesce is assumed before the end of service (EOS) of the machine.

### ii. Replacement Rate

There would be different rates of demand of a replacement part throughout the years. Every replacement part has its life span. Normally, the peak time for the replacement time happens when it comes to the life time of a replacement part after the first shipment of the machine. The need for replacing parts in first year after the machine is sold would be lower than the time when it comes to the life time of the first consumable parts. For example, there would be no headlight needed to be replaced in the first year because the headlight is expected to last for 4,000 hours which is expected to be failing in the second or third year of use. Under this consideration, different rates of replacement in different usage years would be adopted in the forecast model.

iii. **Market Share of 3rd Party Manufacturers**

It is also important to take the market share taken by 3rd party manufacturers into consideration. This factor is normally disregarded by most manufacturers when doing forecasting for their aftermarket parts. If the manufacturer fails to include this, the forecast would probably be over-estimated. It is also noted that the market share of 3rd party manufacturers would vary throughout the periods. Normally it tends to pose an increasing trend.[10]

The company needs to keep an eye on the 3rd party manufacturers and evaluate how many market share got by 3rd party manufacturers. This information is vastly available in some industry reports conducted by marketing research companies. Infotrend has extensive reports regarding the OEM vs Aftermarket in printer cartridges. [10]

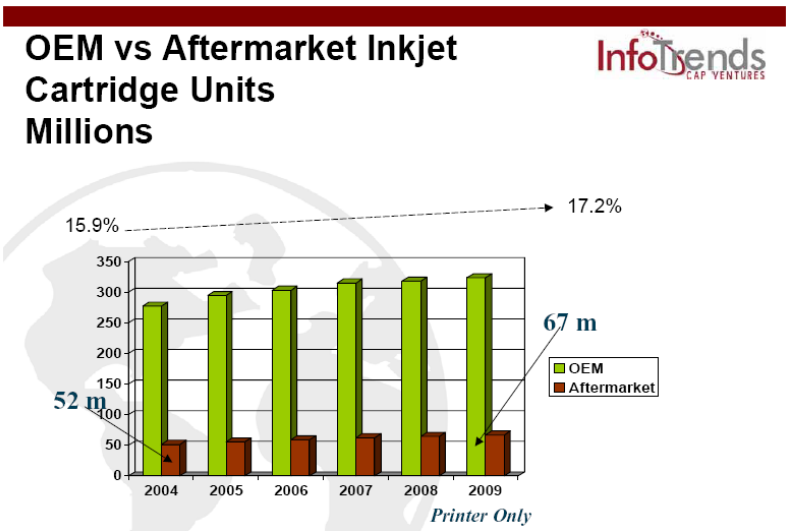


**Figure 3.1 OEM vs Aftermarket Inkjet Cartridge Units (Millions)**

### 3.2 Forecasting Formula

The forecasting formula can be written as follow:

$Q_1 ... Q_i$ : The number of units sold through period (1) to period (i) when the machine is determined end of service (EOS)

$R_1 \ldots R_i$ : The replacement rate of different periods

M : The market share taken by 3rd party manufacturers

$$D_n = \sum_{i=1}^{n} (Q_i \times R_i) \times (1 - M)$$

**Example:**

Forecasting the demand of Headlight for BMW 745Li in 2011

The market share taken by third manufacturer is 20%

| YEAR ($_i$) | Units sold ($Q_i$) | Replacement Rate ($R_i$) | Market Share of original Parts (1-M) | Sub-total |
|---|---|---|---|---|
| 2005 | 200,000 | 5% | 80% | 8,000 |
| 2006 | 500,000 | 5% | 80% | 20,000 |
| 2007 | 800,000 | 10% | 80% | 64,000 |
| 2008 | 600,000 | 20% | 80% | 96,000 |
| 2009 | 400,000 | 5% | 80% | 16,000 |
| 2010 | 200,000 | 1% | 80% | 1,600 |
| | | | **2011 Demand :** | **205,600** |

The annual demand forecasted for the headlight of BMW 745Li is 205,600 units.

## 4. Industry Practices of Product Design

To maintain the performance of its OEM parts, equipment manufacturers should try to create

entry barriers, making it more difficult to 3rd party manufacturers from entering into the market. Some common industry practices are suggested in this section. Every practice has its drawbacks. The company should evaluate the drawbacks and make the most effective combination of practices.

### 4.1 Intellectual Property Rights

Intellectual Property rights such as Patents are the most common practice for a manufacturer to protect its aftermarket. This practice leverages the power of legitimate system to threaten those competitors. It is an effective way to deter big companies to get into the market. In addition, higher entry barrier is built if patents are present. However, it is the most expensive ways as the costs invested in research and development would be tremendous.

**Drawbacks**

1. Patents have its expiration period. Once it reaches its expiry date, it would become invalidate.
2. 3rd manufacturers can easily avoid infringing the patents by making subtle modifications of the original concept.
3. It only has impact in the supply side. On the demand side, most consumers do not care patent infringements

### 4.5 Built-in Protection Mechanism

Having a built-in protection mechanism such as IC chips in its aftermarket parts is also a very common practice. When the machine encounters a non-original aftermarket parts is installed in the machine, the machine will alert the user and cease to operate. Some machines also have a built-in a timer. When it comes to end of life, the machine will also cease to operate until you put a new replacement part that resets the timer. Figure 4.1 shows a projector lamp that has an IC chip built-in recording the lamp timer.

#### 4.2.1 Drawbacks:

i. IC chip is also an expensive component. The manufacturers need to put a lot of efforts in research and development, compatibility testing, etc. But a 3rd party manufacturer can just do a reverse engineering to crack the chip.

ii. After building in an IC ship, an aftermarket parts may be classified as “Electronic Merchandises”. Therefore, some safety certificates such as RoHS would be required. Applying safety certificates for very single aftermarket replacement parts would be very costly. The revenue generated from selling the parts may not be able to pay back the extra overhead spent. In addition, once it is classified as an “Electronic Merchandise”, it would also be charged with higher import duties as compared being an aftermarket replacement part.

**Figure 4.1 A Projector Lamp with a built-in IC ship**

### 4.3 Packaging

A packaging having the brand name of the manufacturer can gain trust from consumers who deserve reliability and quality of the replacement parts. This is the least expensive approach but effective. In most user-replaceable aftermarket parts, the original manufacturers tend to provide the products with color-printed packaging, company logo and a laser genuine mark / label showing give its identity.

#### 4.3.1 Drawbacks

1. Consumers normally would not keep the original packaging of the last consumed part. Therefore, it is difficult for them to identify if the aftermarket replacement part they are buying are an original part. A third party manufacture can also make a nice

color-printed packaging for the non-original aftermarket part, confusing the customers that the parts they are getting are really a genuine aftermarket parts made by the original manufacturer.

2. Some manufacturers, in addition to its own brand name, also OEM manufacture to other brand names, called private labeling. If they keep their own brand name on the aftermarket parts, it makes the manufacturer more difficult in the regard of inventory management.


**Figure 4.2 Color-printed Packaging of HP Printer Cartridge**

### 4.3 Warranty Extension

Warranty extension is a very effective way to retain end users to purchase original parts. [1] Figure 1.1 also shows that Warranty is the second factor an end user would consider when making the purchase. Certainly, an original part can last longer than a part produced by a third party manufacturer. Most of third party manufacturers may not be able to follow what the original manufacturer can offer as it would be relatively risky. The extended warranty can also give end users a peace of mind to purchase the product.

#### 4.4.1 Drawbacks

1. Cost is moderate to offer extended warranty.
2. Extended warranty would result in slight drop in revenue from selling consumables / replacement parts. This would distract channels from stocking the products.
3. Some strong third party manufacturers may be capable to offer the same terms.

Table 4.1 summarizes the effectiveness and cost of different practices in the aspect of product designs.

| Practices | Effectiveness | Cost |
|---|---|---|
| Intellectual Property Rights | LOW\|------[redacted]---\| HIGH | LOW\|--------[redacted]-\| HIGH |
| Built-in Protection Mechanism | LOW\|------[redacted]---\| HIGH | LOW\|------[redacted]---\| HIGH |
| Packaging | LOW\|----[redacted]-----\| HIGH | LOW\|--[redacted]-------\| HIGH |
| Warranty | LOW\|-------[redacted]--\| HIGH | LOW\|----[redacted]-----\| HIGH |

**Table 4.1 Summary of Practices in the aspect of product designs**

# 5. Marketing Tactics in Aftermarket Replacement Parts

## 5.1 Bundling Deals

At the time when the manufacturer sells the machine, a replacement part is bundled in the deal so the customer can get a spare replacement part. Bundling a replacement part, the manufacturer can guarantee the sales of their first replacement part.

### 5.1.1 Drawbacks

i. It is a direct add-up of manufacturing cost, mitigating the competitiveness in the sales of the machine.

ii. Some distributors with low loyalty will keep the bundled replacement parts for resale.

### 5.2 Redemption Coupons

A coupon can be offered to a customer at the time the customer purchases the machine. When the customer needs to buy an original replacement part, the coupon can be redeemed at a discount through the authorized service partners of the manufacture. Manufacturers can set an expiration period in the coupon to make sure the coupon is redeemed.

#### 5.2.1 Drawbacks

i. This is just an incentive for the customer to buy from authorized channel. Unless the coupon value is high, otherwise there would still be a big price gap between OEM parts and 3rd party manufacturing parts.

ii. Distributors with low loyalty may misuse coupons.

### 5.3 Trade-in Rebate

Trade-in rebate could be an incentive for the customer to get a discount from the authorized channels by bringing back the old defective or consumed parts. The manufacturer can also prevent the old parts from re-cycling by 3rd party manufacturers which may refurbish the old parts to save molding cost for reverse engineering.

#### 5.3.1 Drawbacks

i. Distributors with low loyalty may re-sell those take-back parts to other non-OEM manufacturers for the sake of higher return.

ii. The manufacturer has to spend extra expenses to dispose of the old or defective take-back products.

Table 5.1 summarizes the effectiveness and cost of different practices in the aspect of market tactics.

| **Marketing Tactic** | **Effectiveness** | **Cost** |
|---|---|---|
| **Bundling Deals** | **LOW\|--------\|-\| HIGH** | **LOW\|--------\|-\| HIGH** |
| **Redemption Coupons** | **LOW\|---\|------\| HIGH** | **LOW\|-\|--------\| HIGH** |
| **Trade-in Rebate** | **LOW\|---\|------\| HIGH** | **LOW\|----\|-----\| HIGH** |

**Table 5.1 Summary of Practices in the aspect of marketing tactics**

## 6. Distribution Channels of Replacement Parts

Availability is the most important in aftermarket replacement parts. Selling the replacement parts through right distribution channels would improve the performance in the aftermarket. There are several common channels that the manufacture can work with. This section can give an insight for a manufacturer to evaluate what combination of channels are the best fit to its scenario so it can allocate appropriate resources to manage the distribution channels.

### 6.1 **Service Channel**

Service channel is a channel constituted by Authorized Service Partners(ASP) of the manufacturer. These ASPs are normally service or repair centers designated by the manufacturers though some of them are operated and owned by the manufacturer. When the machine is broken, the machine user will send the machine to the repair center or ASP for repair. This channel provides more services to the machine user and charges higher margin for the parts replaced. However, some service centers with low loyalty would recommend the user to replace the consumed replacement parts from 3rd party manufacturer and make higher margin.

### 6.2 Part Channel

Some companies only deal with parts and is highly specialized in part distributors. These companies are called Parts distributor. There are over millions of parts they carry in their inventory. Most parts are added into their system so dealers or some service centers can search the parts they need by using the part number as keyword through their website or catalogues. Dealers would consider this kind of companies as Experts as normally they can find what they want through part distributors. Nevertheless, these companies provide limited service to its customers.

### 6.3 Point-Of-Sale Channel

Point-Of-Sale channel, either online or brick-and-mortar, is where the end user purchases the machine. It is normal that the end user will purchase the consumables or replacement parts from where they purchase the machine. However, this channel does not keep stock for aftermarket replacement parts and this channel is not very technically knowledgeable. Lower margin is normally made by this channel.

### 6.4 Direct Sales Channel

Direct Sales channel means the manufacturer has its storefront, either brick-and-mortar or official website, to sell the parts directly to end users. More and more manufacturer would operate a storefront under its own brand name and work with a 3rd party logistics partner to complete order fulfillments. Price management is a controversial issue in Direct Sales. If pricing is not managed well, it would distract all distributors representing the brand name of the manufacturer as revenue from selling the aftermarket parts is one of main income streams of distributors. Unless the manufacturer has a strong brand name and reputation, it is not recommended to have its direct storefront for selling replacement parts. Dell was ranked number 2 in inkjet and laser vendor in terms of 2005 year to data printer sales[11]. Its direct distribution approach retained its customers well to buy the original products.

| Channel | Volume | Margin | Service Level | Product Knowledge | Loyalty |
|---|---|---|---|---|---|
| **Service** | High | High | High | High | Low |
| **Part** | Low | Medium | Low | Low | Low |
| **Point Of Sale** | High | Low | Low | Low | High |
| **Direct** | High | High | High | High | High |

**Table 6.1 Summary of Distribution Channel of Replacement Parts**

## 7. Conclusion

Many manufacturers are not well prepared for the aftermarket, allowing those 3rd party manufacturers to share a portion of the market. The simple forecast model can help the manufacturer forecast the demand of the aftermarket replacement parts they need to prepare to serve their customers. This is important because when the users can get the replacement parts right away when they need it, normally they do not seek alternative solution. Secondly, if the manufacturers are aware of competition from 3rd party manufactures, they can do more prevention cures in their research and development, or in their product designs. Finally, with a series of strong channels to distribute their replacement parts and some marketing tactics, the manufacturer can build up a strong firewall that deters third party manufactures from getting into the market.

## 8. Future Research

Replacement Rate in the forecast model is the most varying factor that determines the accuracy of the forecast. Every product (or industry) has different rates of replacement parts needed throughout the product life cycle. It is suggested to develop an index table with analytical methods for different industries to apply in their forecasting system.

The forecast model can also improved by breaking down to monthly forecasting demand. Seasonal fluctuation should also be taken into calculation. Having a by-month forecast can ensure even better availability of the replacement parts.

# Appendix

## i. References

**[1]** National Center for Remanufacturing and Resource Recovery, "Remanufactured Toner & Inkjet Cartridge Business Climate Sample Survey Report", Rochester Institute of Technology, pp. 17, 2004.

**[2]** Capgemini Consulting, Institute of Technology Management, University of St. Gallen. 2010. The Aftermarket in the Automotive Industry, pp. 13-14, 2010.

**[3]** Wikipedia, "Aftermarket (merchandise)", March 2011, http://en.wikipedia.org/wiki/Aftermarket_(merchandise)

**[4]** Wikipedia, "Install Base", March 2011, http://en.wikipedia.org/wiki/Installed_base

**[5]** Capgemini Consulting, Institute of Technology Management, University of St. Gallen. 2010. The Aftermarket in the Automotive Industry, pp. 7, 2010.

**[6]** Tricia Judge, "Finding on Remanufactured Cartrdige" in *Imaging Spectrum Magazine*, Int'l ITC, 2004

**[7]** "The 2004 Projection Lamp Supply Chain Report", Insight Media, LLC, pp 35, 2004

**[8] "**Global TV Report", NPD, Intelect, Q1'10, 2010

John Shane, "USA OEM and Aftermarket Trends", InfoTrends / CAP Ventures, pp. 7, 2010.

**[9]** Department of Investment Services, "Automobile Components & Auto Electronics Industry：Analysis & Investment Opportunities", Ministry of Economic Affairs of Taiwan

ROC, pp5, 2007,

**[10]** Catherine Cresswell, “W European OEM & Aftermarket, Toner & Inkjet Cartridge, Market 2004-2009”, InfoTrends, 2010

**[11]** John Shane, “USA OEM and Aftermarket Trends”, InfoTrends, 2006