A1: Innovation in Companies

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Does innovation matter for EMS companies?
A case Study of Hon Hai Precision
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1. INTRODUCTION

EMS (Electronics Manufacturing Services) industry is a new business model that was born in the 1980's in the United States, and came to be known by the name of EMS by the mid-1990's. The ratio of electronic products that was produced by EMS companies compared to all electronic products used today is about 1:4. It is no exaggeration to say that EMS has developed as an industry to the point that cooperating with EMS companies has become essential to maintain a competitive advantage for electronic firms which owns these brand names.

There has been little research concerning EMS worked on from an academic perspective in the latter half of the 1990's, however, these researches are described by fragmentary views. The existing literature can be divided roughly into two currents. First, as a research, describing formation and the development of EMS as a new productive system in the electronic industry. The second, as a research, that focuses on EMS companies. In particular, research concerning EMS seems to focus on thriving companies such as Solectron Corporation, the leading company during the beginning of the 21st century and the current largest EMS company of Hon Hai Precision. Nevertheless, these case studies only referred to the business expansion or competitive strategies while the in depth case studies of EMS companies are under further investigation.

However, by making a comparison between Hon Hai and other major EMS companies on patent count, Hon Hai’s patent count which is issued by WIPO (World Intellectual Property Organization) and the American Patent office is much larger than others. Furthermore, by taking a look at Hon Hai’s patent contents issued against time distribution, the patent count related to connector product patents is more than half until 2001, whereas it diversified after 2002.

From the above studies, the existing research of Hon Hai leaves two remaining issues. The first issue is the limited details of Hon Hai’s rapid growth in the existing research. The other issue is that in spite of Hon Hai’s patent power, there is no existing research trying to interpret it. Hence, I have made two assumptions here in the light of the above
discussion. First, I assumed that Hon Hai’s continuing growth is involved in the patent power. The second assumption is that Hon Hai achieved prosperity due to efficient adaptation through the use of managing the exploitation and exploration of innovation simultaneously.

This research aims to consider the relation between Hon Hai’s patent and performance. For this purpose, it is instructive to clarify Hon Hai’s patent condition.

2. LITERATURE REVIEW

2.1 Appearance and Growth of EMS

EMS is the abbreviated name for “Electronics Manufacturing Services”, and relates the business model by which activities, from the design of a product, to their development for trial purposes, production, shipping, and repair related manufacturing (Fujisaka, 2001, p. 32). That is, in electronic industry, an EMS firm is a recipient for an outsourcing arrangement made by a recognized electronics brand owner.

EMS is considered a new business model that was born in the 1980’s in the United States and came to be known by the name of EMS by the mid-1990’s. The origin of contract manufacturing and outsourcing in the electronics industry may be traced to the mid-1970s in the United States, when several companies took over the assembly overflow of printed circuit board (Salleh, 2009). Afterwards, these enterprises began expand globally, while gradually increasing their manufacturing activities, expanding their business to include the procurement of services of electronic parts, parts of the design function, product assembling, and distribution business, while improving on surface mounting technology (Akino and 2008). Since the manufacturing market expanded so rapidly in the first half of the 1990’s, the enterprise that specialized in contract manufacturing services came to be known as EMS companies.

The EMS industry has achieved rapid growth with an annual rate of 20–25% throughout the 90's(1). According to IHS iSuppli Market Research, estimates of global outsourced manufacturing revenue will rise to $389 billion in 2012, up 5 percent from $369 billion in 2011. (Market Watch, 16 Nov. 2012 ) (2). The data of IHS indicates that the share of LCD TV outsourcing achieved from 65.1 million, 36 percent in 2010. (Market Watch, 16 Nov. 2011) (3). Additionally, set-top boxes saw 69 percent in 2008, digital cameras, 51 percent in 2009, and mobile phones, 25 percent, also in 2009. The ratio of electronic products that was produced by EMS companies compared to all electronic products was 1:4 in 2009(Akino, 2012).
It is no exaggeration to say that EMS has developed as an industry in that sense, therefore cooperating with EMS companies has become essential for electronic firms who own these brand names in order to hold onto their competitive advantage in the electronics industry. However, there has been little research concerning EMS worked from an academic aspect because the history of EMS is so short. Despite limited research, the existing literature can be divided into two currents and will be addressed in more detail in the following clause.

2.2 System of EMS Literature

Even with the literature available on EMS written from an academic perspective in the latter half of the 1990’s, it is difficult to say that enough research has been accumulated to understand EMS and EMS companies. Despite the research that was done, the existing literature has been criticized on two counts as follows.

First, existing research on EMS defines EMS as a new productive system emerged from the electronic industry (Sturgeon, 1998: 2002; Akino, 2008: 2009). Sturgeon (2002) describes the widespread outsourcing by US firms and pays special attention to the arising suppliers in response to the shedding of non-core assets from US firms. He argued that “To meet the growing demand for full-service outsourcing solutions, suppliers have in many cases had to add entirely new competence areas, increasing their scope of activities while improving quality, delivery and cost performance” (p.455). In addition, he called such firms, ‘turn-key’ suppliers which can be considered EMS companies.

Second, the literature focuses on EMS mainly on major EMS companies. Salleh (2009) traced the development of the new system and the rise of a new breed of firms –Solectron Co. in the United States, Flextronics Co. in Singapore, Hon Hai Precision in Taiwan, and the dynamics of the contract manufacturing industry. In addition, Zhai, Shi, & Gregory (2007) described the firm growth model in EMS companies and its link with their internal capability developments. They argued that the growth of EMS companies takes place along three intertwined dimensions: production, supply chain, and capability. The research is based on multiple in-depth case studies of EMS companies during 2003-2005. They proposed the growth model of EMS companies from a capability perspective, which itself can be broken down into four stages of resources and capability developments: penetration, accumulation, evolution, and adaptation.

Taiwan’s EMS company- Hon Hai has also largely drawn from the competitive strategy (Kin, 2011; Kao, 2011; Katsumata, 2012; Akino, 2012). They argued that Hon Hai has grown rapidly through vertical integration and diversification. (Kin, 2011; Kao,
Moreover, some papers argued that Hon Hai’s competitive advantage rests on the metal mold technology and supply-chain management that acquires cost leadership and can respond to customers’ needs more swiftly (Kin, 2011; Kao, 2011; Akino, 2012).

In summary, the majority of existing research is describing Hon Hai that it can provide cheap and good manufacturing service quickly, which is why Hon Hai became the largest EMS company. This is correct to an extent, but the problem is that Hon Hai also owns a lot of patents compared to other major EMS companies, and existing research does not attempt to interpret it. In brief, the existing research shows the limits of discussion of Hon Hai’s growth.

2.3 Exploitation and Exploration Perspective

The Exploitation and Exploration perspective is published on March’s (1991) pioneering article and have increasingly dominated organizational analyses of technological innovation, organization design, organizational adaptation, organizational learning, competitive advantage and, organizational survival (Gupta et al., 2006). Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution. (pp.71-74).

Based on the framework of exploitation and exploration, a line of literature places emphasis on the relation of both concepts (Gupta, Smith, and Shally, 2006; Raisch, Birkinshaw, Probst, and Tushman, 2009; Lavie, Stettner, and Tuchman, 2010). For example, Gupta et al. (2006) paid special attention to these four related questions: What do exploration and exploitation mean? Are they two ends of a continuum or orthogonal to each other? How should organizations achieve balance between exploration and exploitation—via ambidexterity or punctuated equilibrium? Finally, must all organizations strive for a balance, or is specialization in exploitation or exploration sometimes sufficient for long-run success?

Additionally, Lavie et al. (2010) paid attention to the paradox that originated in the character of exploitation and exploration, and indicated 4 kinds of alternative modes of balancing exploitation and exploration. They are "contextual ambidexterity", "organizational separation", "temporal separation", and "domain separation".

These researches build on the position that treat role of exploitation and exploration as a dependent variable (Cao, Gedajlovic, and Zhang, 2009; Lazer and Friedman, 2007; Lavie and Rosenkopf, 2006; Gibson and Birkinshaw, 2004; He and Wong, 2004;
Siggelkow and Levinthal, 2003; Tushman and O'Reilly, 1996). The literature has paid attention to the organizational/strategic factors to achieve such balance between exploitation and exploration. On the other hand, the literature that treats role of exploitation and exploration as an independent variable gave attention to whether it contributes to high performance or what ratio compared to each other distributed to success (He and Wong, 2004; Siggelkow and Rivkin, 2006; Wadhwa and Kotha, 2006).

Not only is the single index of performance through the effect of exploitation and exploration measured, but also the relation between effective organization study and the new product development are discussed (McGrath, 2001; Benner and Tushman, 2002). McGrath (2001) argued that when adaptation requires innovation, or the creation of variety, exploration is crucial. Moreover, Benner and Tushman (2002) tested hypotheses in a 20-year longitudinal study of patenting activity and ISO9000 quality program certifications in the paint and photography industries. They found that the extent of process management activities in a firm was associated with an increase in both explorative innovations that built on existing firm knowledge and an increase in exploitation's share of total innovations and suggested that exploitation crowds out exploration.

Moreover, Katila and Ahuja (2002) examined the relationship between the search behavior and new product introduction. Their findings in the global robotics industry suggest that firms' search efforts actually vary across two distinct dimensions: search depth, or how frequently the firm reuses its existing knowledge, and search scope, or how widely the firm explores new knowledge.

This research quotes the concepts of exploitation and exploration to clarify Hon Hai's patent data. More specifically, this research aims to clarify that the depth and scope of Hon Hai's search on the basis of Hon Hai's patent data.

3. RESEARCH METHODOLOGY

This research is a single case study of Hon Hai Precision. As described in the foregoing paragraph, the existing literature revealed business expansion and competitive advantage of Hon Hai at large (Zhai, Shi, & Gregory, 2007; Kin, 2011; Kao, 2011; Akino, 2012). In addition, an EMS company is a recipient for an outsourcing arrangement made by a recognized electronics brand owner in electronic industry, so that EMS companies are not considered to having innovative capabilities. Therefore, the research from an innovative viewpoint cannot be found in previous research.
Table 1 shows the differences of Hon Hai’s patent count compared with other major EMS companies. It can be observed that Hon Hai’s patent count that is issued by WIPO (World Intellectual Property Organization) and the American Patent office is much larger than the others.

<table>
<thead>
<tr>
<th>EMS enterprise</th>
<th>Hon Hai</th>
<th>Solectron</th>
<th>Flextronics</th>
<th>Sammin SCI</th>
<th>Jabil</th>
<th>Celestica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulation issue number in World Intellectual Property Organization</td>
<td>971</td>
<td>7</td>
<td>29</td>
<td>52</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Accumulation issue number in American Patent Office</td>
<td>11,771</td>
<td>18</td>
<td>38</td>
<td>54</td>
<td>31</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 1: Comparison of patent accumulation issue numbers of Hon Hai and other major EMS companies

In addition to the patent count, Hon Hai also acquired the high valuation on patent power. According to the sixth Patent Power scorecard of IEEE (Institute of Electrical and Electronic Engineers), Hon Hai ranked second in the electronics category. Additionally, Canon ranked first while Apple ranked third. Moreover, based on the Top-50 U.S(4). Patent Assignees for 2012 announced by U.S. IFI CLAIMS Patent Services, Hon Hai ranked 8th with 2013 count of assigned utility patents(5).

By taking a look at Hon Hai’s patent contents issued against time distribution, it can be observed that the patent count related to connector product patents is more than half until 2001, whereas it diversified after 2002. Patents such as liquid crystal panel technology, nanotechnology and optics technology increased after 2001 remarkably.

As mentioned earlier, Hon Hai achieved a sustained growth without the effects of the collapse of the IT bubble in 2000 in EMS industry. Furthermore, Hon Hai showed an explosive growth rate after 2001 while other major EMS companies declined. Drawing from the above discussion, I have made two assumptions before going into the case study of Hon Hai. The first assumption is that Hon Hai’s sustained growth is involved in the patent power. The second assumption is that Hon Hai achieved prosperity due to efficient adaptation through the use of managing the exploitation and exploration of innovation simultaneously.

In view of Hon Hai’s patent power, patent data is adopted as a clue to interpret Hon Hai’s sustained growth.
Note that this research methodology can be divided into two stages. The purpose of stage one is to create Hon Hai’s patent database. This research treats the utility patent issued as the indicator of innovation. It analyzes the patent contents issued by the Taiwan Patent Office. In addition, the patent data was collected from the Taiwan Patent Office (http://www.tipo.gov.tw/ch/) and the United States Patent and Trademark Office (http://patft.uspto.gov/). This research will carry out an in-depth case study of Hon Hai in stage two. In order to consider the role of patent applications on Hon Hai’s growth, this research thoroughly looked over all the articles concerning Hon Hai on the newspaper during 1975-2001 (Economic Daily News published in Taiwan), and the articles on books and magazines published by Taiwan, Japan, and America.

The major literatures this research used are shown in Table 2.

<table>
<thead>
<tr>
<th>Literature Type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Report</td>
<td>Downloaded from Taiwan Stock Exchange Corporation: <a href="http://newmops.twse.com.tw/">http://newmops.twse.com.tw/</a></td>
</tr>
<tr>
<td>Books</td>
<td>張戊議・張鴻文・盧智芳『五千億傳奇—郭台銘的鴻海帝國』 (天下雜誌出版、2005)</td>
</tr>
<tr>
<td></td>
<td>張鴻文 『虎與狐：郭台銘的全球競爭策略』 (天下遠見出版、2005)</td>
</tr>
<tr>
<td></td>
<td>伍忠賢 『鴻海藍圖』 (五南出版、2006)</td>
</tr>
<tr>
<td></td>
<td>伍忠賢 『億到兆的管理』 (五南出版、2006)</td>
</tr>
<tr>
<td></td>
<td>伍忠賢・張保隆『生產管理：實務個案分析』 (五南出版、2011)</td>
</tr>
<tr>
<td>Magazine</td>
<td>天下雜誌 (Taiwan)</td>
</tr>
<tr>
<td></td>
<td>商業周刊 (Taiwan)</td>
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<td></td>
<td>今周刊 (Taiwan)</td>
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<td></td>
<td>Electronic Business 誌 (America)</td>
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<td></td>
<td>日経ビジネス (Japan)</td>
</tr>
<tr>
<td>Newspaper</td>
<td>経済日報 (Economic Daily News, Taiwan) (Year 1974–2001)</td>
</tr>
<tr>
<td>Database</td>
<td>Science &amp; Technology Policy Research and Information Center (Taiwan): <a href="http://cdnet.stpi.org.tw/techroom.htm">http://cdnet.stpi.org.tw/techroom.htm</a></td>
</tr>
<tr>
<td></td>
<td>Market Intelligence &amp; Consulting Institute (Taiwan): <a href="http://mie.iii.org.tw/intelligence/">http://mie.iii.org.tw/intelligence/</a></td>
</tr>
</tbody>
</table>

Table 2: The major sources of Hon Hai precision

4. Case Study

Hon Hai is headquartered in Taipei, Taiwan and was founded by Chairman Terry Gou in 1974 to make plastic switches for TVs. According to the latest annual report, the market share reached $114,890,000 in 2012, growing at 16% compared to the previous year. Hon Hai has eight business groups across six industries (computing, communications, consumers, digital contents, auto parts, and distribution) in 2010.

This section in turn will take on Hon Hai’s patent data. Figure 1 shows the issued patent count Hon Hai applied every year in Taiwan and the United States. It can be
observed that both patent count issued by Taiwan and America are increasing, 

Figure 1: Patent count issued by Taiwan and United Stated Patent Office  

Figure 2: Patent count of non-Taiwanese/Chinese inventor vs. Taiwan/Chinese inventor issued by Taiwan Patent Office  
Source : Taiwan Patent Office (http://www.tipo.gov.tw/ch/)  

Figure 2 and 3 displays the inventors' nationality of patent issued by Taiwan and the United States. As it can be seen on Figure 2, the inventors' nationality of patent count issued by Taiwan are almost all non-Taiwanese/Chinese before 2002. Moreover, as it can be seen on Figure 3, the non-Taiwanese/Chinese inventors account for 1/2 of the total count before 1996. This data can be said that Hon Hai relied on the knowledge from foreign countries. In reality, Hon Hai placed the R&D base in Cypress, United States in 1985. It can be observed from Figure 2 and 3 that the Taiwanese/Chinese inventor of patent count is increasing as time goes by. Hence, it could be argued that
Hon Hai absorbs knowledge from foreign countries and takes it into R&D capability for itself.

What patents Hon Hai applied have been issued? Hon Hai’s patent contents can be shown by means of International Patent Classification (IPC). The following table (see Table 3) of the ranking of Hon Hai’s patent count based on IPC is indicating the section type of patent Hon Hai has applied and issued the most. The most patent issued to Hon Hai applied is the digital computing or data processing equipment or methods, specially adapted for specific functions that belong to the category of G06F. The patent account following the G06F is H01R, the patent contents related to connector products. Furthermore, the patent allied to the manufacture of assemblage of electrical components, optical elements, systems, or apparatus and semiconductor devices also rank within the top 10.

As Figure 4 shows, the patent count related to connector products account for more than half of the total count. On the other hand, as it can be seen on Figure 5, the issued patent contents Hon Hai applied in Taiwan appear to be mixed. It can be inferred that Hon Hai continued the exploitation of connector technology during the 1990’s, whereas the exploration of diverse technology continued after 2001.
<table>
<thead>
<tr>
<th>International Patent Classification</th>
<th>Count</th>
<th>International Patent Classification</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 G06F: Digital computing or</td>
<td>576</td>
<td>6 G03B: Apparatus of arrangement</td>
<td>196</td>
</tr>
<tr>
<td>data processing equipment or</td>
<td></td>
<td>for taking photographs of</td>
<td></td>
</tr>
<tr>
<td>methods, specially adapted for</td>
<td></td>
<td>projecting</td>
<td></td>
</tr>
<tr>
<td>specific functions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 H01R: Electrically-conductive</td>
<td>450</td>
<td>7 H04N: Details of television</td>
<td>123</td>
</tr>
<tr>
<td>connections</td>
<td></td>
<td>systems</td>
<td></td>
</tr>
<tr>
<td>3 H05K: manufacture of</td>
<td>264</td>
<td>8 H01J: Electric discharge</td>
<td>118</td>
</tr>
<tr>
<td>assemblage of electrical</td>
<td></td>
<td>tubes or discharge lamps</td>
<td></td>
</tr>
<tr>
<td>components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 G02B: Optical elements,</td>
<td>264</td>
<td>9 H04L: Transmission of digital</td>
<td>113</td>
</tr>
<tr>
<td>systems, or apparatus</td>
<td></td>
<td>information</td>
<td></td>
</tr>
<tr>
<td>5 G02F: The optical operation of</td>
<td>220</td>
<td>10 H01L: Semiconductor devices;</td>
<td>90</td>
</tr>
<tr>
<td>which is modified by changing</td>
<td></td>
<td>electric solid state</td>
<td></td>
</tr>
<tr>
<td>optical properties</td>
<td></td>
<td>not otherwise provide for</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Ranking of Patent contents based on IPC
Source: Taiwan Patent Office (http://www.tipo.gov.tw/ch/)

Figure 4: Contents of patents issued by Taiwan Patent Office against time distribution (before 2000)
Source: Taiwan Patent Office (http://www.tipo.gov.tw/ch/)
Finally, here is the reckoning of ranking of self-citation based on IPC for patent count issued by the Taiwan Patent Office until 2005 (see Table 4). Hon Hai’s exploitation of connector products turns out to be much clearer. By means of search depth and scope that Katila and Ahuja (2002) pointed, search of depth means how frequently the firm reuses its existing knowledge, which can be said about Hon Hai’s frequent self-citation of connector products. Referring back to Katila and Ahuja (2002), the variable search depth describes accumulation of search experience with the same knowledge elements. They argued that the more knowledge a firm uses, the more profound meaning behind the knowledge is found by the firm. Thus, search depth was measured as the average number of times a firm repeatedly used the citations in the patents it applied for. This research builds on Katila and Ahuja’s (2002) detailed study of search behavior. It can be said that Hon Hai tried to understand how connector products and optical technology are related.
5. Conclusion

So far, Hon Hai's detailed patent condition about count and contents issued by the Taiwan Patent Office and the United States Patent and Trademark is mentioned. As mentioned above, Hon Hai had applied patent related to connector products mostly and relied on the knowledge from foreign countries during the 1990s', whereas it diversified the scope of patent contents and also continued the exploitation for connector product technology after 2001. In sum, this research can be summarized into findings as described below.

The first finding is that Hon Hai had relied on technology from foreign countries at the beginning and then absorbing it. Since Hon Hai's R&D base was placed in Cypress, United States in 1985, and the non-Taiwan/Chinese inventors comprised of more than half of the patent count, these phenomenon purport to support this finding.

The second finding is that Hon Hai continued the exploitation of electrically-conductive connections technology (H01R) activities. In the data discussed in the previous section, IPC of H01 ranked second of patent counts. Moreover, the most count of self-citation is also the IPC of H01R. According to the Economic Daily News published in Taiwan, Hon Hai was the first connector manufacturer that obtained the manufacturing license of Pentium Pro by Intel in 1995. In addition, the connector products also yielded the largest profits in 1995.

The third finding is that Hon Hai managed the exploitation and exploration activities simultaneously. It can be described by means that Hon Hai had continued applying for

<table>
<thead>
<tr>
<th>Rank</th>
<th>IPC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H01R</td>
<td>Electrically-conductive connections</td>
</tr>
<tr>
<td>2</td>
<td>G02B</td>
<td>Optical elements, systems, or apparatus</td>
</tr>
<tr>
<td>3</td>
<td>G03B</td>
<td>Apparatus of arrangement for taking photographs of projecting</td>
</tr>
<tr>
<td>4</td>
<td>G02F</td>
<td>The optical operation of which is modified by changing optical properties</td>
</tr>
<tr>
<td>5</td>
<td>H04N</td>
<td>Details of television systems</td>
</tr>
</tbody>
</table>
patents of the IPC section H and expanded the scope of R&D to IPC section G related to optical technology. In doing so, Hon Hai succeeded in the development of optical connector in LAN or communications cables in 1996, which became a high profit product.

The fourth finding is that Hon Hai keeps developing its own digital computing or data processing equipment or methods, specially adapted for specific functions (IPC of G06F) as the scale of the organization is enlarged. It might be a possible explanation for Hon Hai’s success.

In conclusion, Hon Hai has done the managing the exploitation and exploration activities simultaneously based on the patent data. In addition, Hon Hai’s patent power is a possible factor in explaining Hon Hai’s success. However, it goes without saying that there are some limitations that can be pointed out. This research lacks ample amounts of interpretations to prove how innovation (patent power) related to performance positively. Besides, what single case of Hon Hai can tell about theoretical implications? These problems need to be addressed in future research.

Notes:


http://www.isuppli.com/Manufacturing-and-Pricing/MarketWatch/Pages/LCD-TV-Outsourcing-Set-to-Doublenas-Competition-Intensi%EF%AC%81es.aspx

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