Chapter 4

Case Study of the Electronics Industry in the Philippines: Linkages and Innovation

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Abstract

The Philippine electronics industry is one of the most critical industries in the Philippines. In 1996, it has surpassed the agriculture sector as the top export earner of the country and has not been toppled from that position ever since. In its more than three decades of existence, the industry has concentrated on the lowest segment of the value chain, assembly and testing, and have seemingly created a niche in this area, particularly in semiconductor electronics. However, this study found that even in that position, electronics firms in the Philippines have done upgrading covering products, processes and substantial organizational innovation. There were exceptional firms that have moved up the value chain and into design and more advanced production processes. The location of these firms, indeed, the industry's concentration in CALABARZON has enabled the transfer and exchange of knowledge coming more strongly from the production side, than from the holders of knowledge such as the academe, research institutions and other sectors. The participation of the firms in the regional and global production networks have also contributed to their upgrading efforts. In turn, the industry has transformed the region into a manufacturing/industrial hub that augured well for local economic development. This study which looked at cases of ten electronics firms located in CALABARZON provides detailed account of inter-firm production linkages and collaboration with knowledge stakeholders as pathways toward industrial upgrading and innovation. It was found that production linkages are the stronger mechanism and that internal strategies and toolkits by the firms themselves drive their innovative activities as stimulated by competitive pressures and demands of customers. Insights from this case study would contribute towards developing the framework for the establishment of a pan-industrial corridor in the Asian region taking into account the participation of Philippine electronics firms in the regional production networks.

1. INTRODUCTION

The Philippines, like its neighbors in Asia, is a destination for large foreign firms (multinational enterprises) that outsource production processes or have opted to adopt a process of fragmentation in their business configuration. The country's competitiveness

is widely believed to rest on the back of its low cost human resources that offer an edge when it comes to producing quality outputs. Another leveraging factor is the advantage of Filipino manpower when it comes to the language of business, with English considered a second language in the country. This influx of foreign investments came on the heels of liberalization and deregulation policies that eased their entry and enabled the formation of industrial agglomerations. The region that benefitted most from this phenomenon is CALABARZON (Cavite-Laguna-Batangas-Rizal-Quezon), whose proximity to Metro Manila, the National Capital Region, made it an alternative to the increasingly congested metropolis. It helped that many of the industrial economic zones that sprouted all over the country was located in this region. Soon it became apparent that manufacturing activities in the country were concentrated in CALABARZON, while Metro Manila focused on the burgeoning services sector.

In 2008, a paper looking at the sources of innovation of Philippine firms based on a survey of 204 firms engaged in different manufacturing activities located in CALABARZON, found empirical evidence that production linkages have a strong influence on the propensity of firms to undertake industrial upgrading. It was also found that firms in the region have weak collaborations with knowledge stakeholders within and outside the region (Macasaquit, 2008). Following through on this study, this paper aims to take this past effort further and present concrete evidences of inter-firm production linkages as well as firm-knowledge stakeholders' collaboration in relation to industrial upgrading and innovation. The evidences of inter-firm production linkages relating to upgrading; the factors that hinder the formation of linkages; types of partners considered to matter when it comes to innovation; the modes of collaboration; and the role of public policies and programs, will be examined in the context of firms' location in an industrial agglomeration.

This study will involve a case study of firms in the Philippine electronics sector to

delve deeper into the linkages involved, determine the mechanisms and trace the pathways to industrial upgrading and innovation. Among all the manufacturing industries in the Philippines, electronics is the most entrenched in the regional/global production networks. Moreover, it has the largest contribution to export earnings and highly concentrated in CALABARZON. As the industry has existed for more than 30 years, it is interesting to determine if it has evolved from low value added production activities to higher segments of the value chain in order to improve its competitiveness in the face of increasing penetration of China in the global electronics industry. In this context, to what extent has its participation in production networks improved its technological capability to upgrade and innovate? More than production linkages, what is the extent of contribution of the firms' collaboration with knowledge stakeholders, if any? Given the characteristics of the electronics industry in the Philippines, it is assumed that the most important partners for upgrading and innovation are their affiliates, customers and suppliers that are located within, across agglomerations or outside of the country. Their linkages with knowledge stakeholders are limited, as it is true for other industries in CALABARZON, since technological capabilities in the government and academe are perceived to be lacking and still needs significant improvements.

The paper is organized as follows. The next sub-section provides an overview of CALABARZON as the premier industrial manufacturing cluster in the country, its role and contributions to national output. This will be followed by a brief profile of the Philippine electronics industry which is the subject of this case study. The second section provides a brief background on the current conditions of production networks in the region and where the electronics industry can be situated. It is also in this section where the Philippine electronics sector is described in the milieu of the current technological capabilities of the country. The following sub-section provides

information on government policies directed towards the industry. Meanwhile, the third main section presents the summary of the results of the firm interviews, followed by the analysis based on the survey of firms conducted in the latter half of 2009 and on the case study itself. The final section concludes and attempts to enumerate policy recommendations.

2. OVERVIEW

2.1. The CALABARZON Region

The CALABARZON region, also known as Region IV-A comprises half of the so called Southern Tagalog provinces (with the other half composed of Region IV-B or the MIMAROPA provinces). As described in the Regional Development Plan for the region for the years 2004-2010, CALABARZON is claimed as one of the country's major economic hubs and a global industrial region. Together with the National Capital Region (NCR) and the industrial parts of Central Luzon, CALABARZON rounds up part of the so-called Metropolitan Manila Growth Network. This refers to the country's "biggest aggrupation of urban areas performing various roles such as main industrial core, financial and commercial center, seat of national government, and transshipment points for goods and services for domestic and international distribution (NEDA, 2004)."

While collectively described as such, the region is a diverse amalgamation of provinces that are partly urban and partly rural that can be observed by their physical attributes and socio-economic characteristics. In the spatial strategy for the region, development planners have laid down two broad areas of development, the urban growth cluster and the non-urban growth cluster, to capture the regional context as a whole. Said to be at the core of the region, the urban growth cluster is composed of highly urbanized and contiguous municipalities and cities where the industrial sector can mostly be found. This particular cluster serves as a magnet for employment and

migrants from the rural areas seeking out opportunities in the urban areas. In fact, the region earned the distinction of being the most populous region in the country in 2007, surpassing Metro Manila, with more than 11.7 million people to the latter's 11.6 million. The region's population growth rate from 2000 to 2007 reached 3.24 percent, higher than the rate for NCR and even, the national level.

In terms of its contribution to the national output, CALABARZON's Gross Regional Development Product (GRDP) grew by 4.0 percent from 2003 to 2004 but dipped to 2.6 percent in the period spanning 2004 to 2005. The region's GRDP recovered from 2005 to 2006 to a significant 4.6 percent. Highlighting the importance of the region to the nation's income, its tandem with NCR and Region III accounted for about 60 percent of the country's total output in 2002. Reflecting the economic structure of NCR, CALABARZON's industry and services sectors have contributed the most to the regional coffers. In terms of the region's industry sector, the main contributor was manufacturing which in turn was being boosted by the performance of the economic zones mainly scattered throughout Cavite, Laguna, Batangas, and to some extent, Rizal. The products coming out of the manufacturing plants in these provinces are primarily semiconductors and electronics outputs intended for the export-market. It was noted that the share of the industry sector in CALABARZON's GRDP has consistently been the biggest among the three major sectors, however, the services sector has been closely catching up, driven mainly by the sub-sectors finance; trade; transport, communication and storage; and private services.

Despite the shifting economic structure in the region in favor of services sector which is growing faster than the industry sector, CALABARZON would still be known as the manufacturing cluster of the country owing to the 42 economic zones existing across the region, with 9 more being developed as of December 2009. This total accounts for about a quarter of the total economic zones dotting the country. While

these ecozones are mainly into export-oriented manufacturing, a few are concentrating on information technology-based services like business process outsourcing.[1]

Based on the mid-term assessment of the National Economic and Development Authority (NEDA) conducted in 2008 on the performance of the region based on the CALABARZON Development Plan for 2004 to 2010, there were unmet GRDP and unemployment targets and foreign and domestic investments were not within desired levels. This underperformance was attributed to the declining growth of the manufacturing sector though remaining positive during the reference years, which were said to be caused by hindering factors affecting the efficient operations of the firms even those located in economic zones. Moreover, the flows of investments were not at par with the country's neighbors. The report highlighted the fact that there is a need to improve the pull factors in the region through better infrastructure facilities, improved human capital, maintenance of peace and order, and overall, a better business environment conducive to new and additional investments. Beyond these measures however, there is a need to upgrade the productive activities in the industrial cluster from low value added manufacturing towards the higher segments of the value chain particularly in the face of increasing competition from other countries with similar attributes. In theory, firms in industrial clusters, aided by the spillovers of technological knowledge by the various actors within it, should graduate from mere production to higher value added activities like design, high grade research and development (R&D), advanced marketing strategies, among others. The opportunity and the means to innovate is one of the advantages of being in an industrial agglomeration.

Partly aimed at determining if firms in CALABARZON have undergone innovation

[1] For more detailed discussion about the attributes of CALABARZON and each of its 5 provinces, see Macasaquit, 2008 which is part of the sub-supporting study for the ERIA research project implemented in 2008 to 2009.

and mainly to find out their sources of technological knowledge, a survey of firms in the area was conducted in late 2008 involving over 200 firms engaged in different business activities. It was found that majority of the firms surveyed have undergone both product and process innovations. In terms of the former, new products were introduced to the market albeit mostly for existing ones and produced by utilizing existing technologies. On the other hand, process innovation was mainly through acquisition of new machines, improvement of existing ones, adoption of international standards in order to be certified, and institution of internal mechanisms for improvement. These innovations were achieved despite having only about 25 percent of firms with formal R&D units, indicating that there were other sources of technological information. The study concluded that production linkages as well as interaction with other firms (including competitors) matter to a firm's propensity to innovate as evidenced by the responses from manufacturing firms in CALABARZON. In fact, this type of linkage mattered most to these firms than intellectual linkages which were found to be weak (Macasaquit, 2008).

The results of that study alone have shown that firms in CALABARZON do innovate whatever the level and degree, and have different sources of technological information that matter to innovation. In as much as the study involved firms engaged in different business activities and therefore shows the macro picture, it would be interesting to look at particular sectors and find out what drives them to innovate, if proximity or being located in an agglomeration does matter for innovation and what specific pathways or linkage mechanisms are at work that lead to firm-level upgrading.

2.2. The Electronics Industry in the Philippines

In terms of industry profile, the clusters that emerged in CALABARZON included food, electronics, textiles and garments, automobile and auto parts, and agribusiness.

Over the years, these eventually became the drivers of Philippine industry, generating export earnings and employment. In the last decade, the electronics industry in the Philippines has been its top export earner and a primary recipient of foreign investments. This remains true despite the fact that export earnings were practically chopped into half, from around US$31 billion in 2007 to around US$15 billion in 2009 due to the global economic slowdown. The electronics industry has been a significant provider of employment as it has absorbed over 460,000 persons deployed in 476 firms as of October 2009 (BOI, 2009). These companies were located mainly in CALABARZON and Metro Manila, while Cebu and other parts of Luzon were also hosts to these enterprises. In the listing obtained recently from the Philippine Economic Zone Authority (PEZA), it was noted that among locators in economic zones in the country, 372 firms were classified under the electronics and semiconductor industry. This implies that a significant number of electronics firms are export oriented.

The electronics industry in the Philippines is primarily engaged in assembly and test manufacturing, but also in other highly technical but labor intensive activities. It is in this area where the country has carved a niche for participation in the regional/global production networks. Regional or global production networks are recent business configurations wherein a flagship firm breaks down the value chain in its various essential components and locates them where they can be more efficiently produced, thereby improving the firm's access to resources and capabilities. Relocating components of their value chain enables the firm to focus on its core business, while reducing costs of production given its outsourcing option.

The electronics industry in the Philippines is being classified into nine categories namely:

(1) Components and devices: Pentium IV, integrated circuits, transistors, diodes, resistors, coils, capacitors, transformers, lead frames, PCB

(2) Computer-related products and electronic data processing: personal computers, HDDs, CD ROM, mother boards, software development, data encoding and conversion, systems integration customization

(3) Automotive electronics: telematics – global positioning system, hybrid car and safety

(4) Consumer electronics: flat panel TV, high definition TV, set top box, iPod, digital cameras

(5) Office equipment: photocopy machines and its parts, electronics calculators

(6) Communications and radar: 3G handset, TV reception in handset, mobile services, radars

(7) Telecommunications: telephones, scanners, satellite receivers, cellular phones

(8) Control and instrumentation: PCB assembly for instrumentation equipment

(9) Medical and industrial: RFID, energy saving control, green electronics, optical recognition.

The history of the electronics industry in the Philippines can be traced to the 1950s when US electrical companies came in to produce home appliances. The same type of production was done by Japanese companies when it followed suit and as with US investments, also went into joint venture endeavors with local entrepreneurs. Next came the back-end processes of semiconductor assembly in the 1970s, which was again introduced by US-based companies, The manufacturing of semiconductors was oriented towards exports while home appliances production was for the local market. In the mid-1980s, electronics companies from Japan, triggered by *endaka*, moved their production sites to ASEAN countries such as Singapore, Thailand and Malaysia. Due to political instability reigning in its shores during this period, the Philippines was bypassed by this first wave of Japanese investments. Recovering from decades of

political instability and stagnant growth, a flurry of liberalizing policies were instituted in the 1990s in an attempt to reform the country's image and make some necessary structural adjustments. In 1994, these efforts paid off as large inflows of foreign investments poured into the manufacturing sector in the country (Morisawa, 2000). Japanese investments in the Philippines during this period in the electronics industry were mainly in the production of personal computer peripherals such as floppy disk drives (FDD), hard disk drives (HDD), mother board, among others. Between 1994 and 1996, four major Japanese HDD companies came into the country accompanied by a number of Japanese supplier firms (Tecson, 1999).

2.3. The Rationale for Upgrading/Innovation

In an environment of increasing globalization, changing market environment, reconfiguration of organizations (fragmentation versus integration), widening opportunities presented by regional and global production networks, industry players – mainly the firms –have to undergo structural transformation by means of shifting from the production of low value added goods and services to more diverse, complex and high value added production. This is one of the ways to buttress their competitiveness in the face of fierce competition. Increasing competitiveness require the adoption of measures to modify production processes, introduce new products, initiate improved organizational systems, apply new marketing methods, and tap new markets. All these denote efforts toward industrial and/or firm-level upgrading or the application of innovation in production and within the organization. There are numerous sources of technologies that could lead to industrial upgrading and innovation.

It is claimed by many firm-level studies that the process of technological learning among firms is characterized with externalities and linkages. It is driven by links with suppliers of inputs or capital goods, competitors, customers, consultants, and

technology suppliers. Also important are interactions with firms in unrelated industries, technology institutes, extension services, universities, business associations, and training institutions (Lall 2001 as cited in ADB 2009). The first refers to production stakeholders where primary transactions are in the areas of buying and selling. This also covers the firm's own mechanisms or strategies for generating technological knowledge and applying them to its production, organization, and marketing. On the other hand, the second major source of technological information are the knowledge stakeholders, generators and repository of technical research, science and technology data and materials, results of experimentation, among others.

Production linkages and the occurrence of technology transfers can lead to innovative activities, with the location of firms – industrial clusters – as an important site of information exchange. Indeed, it has been empirically proven that knowledge spillovers do occur in such agglomerations and proximity matters. In addition, collaboration with the so-called knowledge stakeholders that are sources of science and technology ideas such as universities, public and private research institutions and industry associations can likewise stimulate technological learning and adoption. This is particularly true in advanced economies where university-industry linkages do exist. Previous studies have shown that this may not be the case in developing or emerging economies as their main suppliers of technological information have so far been those within their production web.

The Philippine electronics industry is in a critical juncture. Parties claim that it seems to be the only shining star remaining in the country's manufacturing sector. Yet, it is facing tougher competition from China and other countries that also offer low-cost labor and at the same time, enticing foreign investments with more lucrative incentives. According to the Congressional Committee on Science and Technology and Engineering (COMSTE), the key to the continued success of the electronics industry in

the country is the development of a strong applied R&D infrastructure and innovative culture. There is a need for it to move up the value chain through innovation; transfer technology from the universities; grow local markets for its products; and attract new investments in growth areas such as chip design, green technology and biomedical electronics (Tangonan, 2008). The next section provides information on the current milieu where the Philippine electronics industry is situated.

3. THE PHILIPPINE ELECTRONICS INDUSTRY: AGGLOMERATION AND PRODUCTION NETWORKS FOR UPGRADING AND INNOVATION

The importance of the electronics industry in the Philippines cannot be denied. From 1998 to 2007, the industry contributed 60% to almost 70% of total export earnings of the country. The figures recently went down to 58% in 2008 and about 57.8% in the first three quarters of 2009 due to the impact of weak demand arising from the global economic slowdown. Still, it remains apparent that electronics in the country continuous to be its top export earner and indeed, an export winner.

Many of the electronics firms in the country, big or small, are located in economic zones concentrated in the CALABARZON region. This implies the export orientation of these firms, whether directly or indirectly to various parts of the world. The US, Japan, Netherlands, and Hong Kong are traditionally the major destinations of electronics outputs, with China beginning to take on the role of major market for Philippines electronics in recent years. In 2008, mainland China earned the distinction as the top export destination of Philippine electronics, having had the highest percentage among 11 of its major trading partners, followed by Hong Kong. In terms of niches, it has been observed that the Philippines have taken on the role of assembler and tester for the electronics industry as a whole, and mainly on semiconductors in the past 30 years. This denotes that many of the electronics firms in the country find themselves in the

lower tier of the production chain. There are however, notable exceptions to this fact indicating that there are firms that were able to evolve from assembly and testing activities to turn key production.

3.1. The Regional Production Network in Asia and Philippine Electronics

The industrialization of countries categorized as newly-industrializing economies (NIEs) namely, Singapore, Hong Kong, Korea and Taiwan is closely tied up to the search of Japanese multinational companies for quick and low-cost production sites.

From simple and labor-intensive assembly and testing of parts and components, the NIEs caught up and soon became OEMs in their own right. Perhaps due in part to this and their new-found development, labor costs in NIEs begun to rise in mid-1990s, causing firms in the NIEs to shift their manufacturing in other areas in the region, specifically to the ASEAN-4. This resulted in a radically different regional/geographical production arrangement with the NIEs now serving as first-tier suppliers to the lead firms, and the ASEAN countries (including China and India) taking the role of second-tier suppliers to the NIEs, doing many of their assembly and testing requirements. This is evident in the surge of foreign direct investment (FDIs) flows in ASEAN particularly in the electronics manufacturing sector. Austria (2008) also noted the increasing role of the ASEAN region to the global electronics production, as seen on rising export and market shares.

Eventually, ASEAN countries including the Philippines were able to develop their respective niches in this new production network. Malaysia and Thailand gained strength in components assembly while the Philippines is seen to be most competitive in semiconductor as it practically dominated the country's electronics export products, and supplies 10% of the world's semiconductor manufacturing services requirements (SEIPI, 2007).

The Philippines' participation in the regional electronics production network significantly altered its economic and trade structure. From a predominantly agri-oriented exporter in 1976,[2] the country now exports billions worth of microchips and electronic devices. Moreover, from a mere $1.5 billion in 1990 (CPBO, 2009), the industry's export revenues rose to $31 billion in 2007, accounting for over 60% of the country's total exports for the period 2000-2007.

Table 1 Philippine Exports of Electronics, By Sub-Sectors, 2004-2009
Value (in million US$)

	2004	2005	2006	2007	2008	2009[p]
Total Exports	39,680.52	41,254.68	47,410.12	50,465.72	49,023.17	27,639.13
Electronics	26,726.08	27,298.73	29,500.20	31,085.27	28,500.91	15,981.66
Components/Devices (Semiconductors)	18,706.78	20,207.31	22,321.80	23,624.39	21,046.84	11,395.02
Electronic Data Processing	6,193.10	5,504.28	5,557.08	5,458.36	5,213.66	3,354.89
Office Equipment	209.96	194.63	268.08	335.54	315.15	173.37
Medical/Industrial Instrumentation	4.04	6.45	13.10	33.33	31.88	21.72
Control And Instrumentation	10.24	15.58	17.17	38.79	53.58	29.10
Communication And Radar	449.18	269.55	234.37	276.04	290.44	237.81
Telecommunications	177.69	136.90	213.58	124.62	261.07	99.28
Automotive Electronics	363.06	397.31	415.95	610.71	809.65	455.71
Consumer Electronics	612.03	566.73	459.06	583.50	478.63	214.76

Note: p Preliminary figures for January to September.
Sources: For 2004-2006: Department of Trade and Industry (available at: http://tradelinephil.dti.gov.ph/betp/trade_stat.expcod_sumprod)
For 2007-2008/1Q2009: National Statistics Office (available at www.census.gov.ph).

[2] According to SEIPI, 49% of the country's exports in 1976 were agro-based.

Table 2: Philippine Exports of Electronics, By Major Trading Partners, 1995-2009
Value (in million US$)

	2004	2005	2006	2007	2008
Total Exports	39,680.52	41,254.68	47,410.12	50,465.72	49,023.17
Total Electronics	26,726.08	27,298.73	29,500.20	31,085.27	28,500.79
U.S.A.	2,869.02	3,300.29	4,112.76	4,152.69	3,936.77
Japan	5,625.22	4,845.64	4,263.90	3,413.41	3,455.15
Germany	1,103.94	950.02	1,348.16		2,007.31
Netherlands	3,151.41	3,530.67	4,274.43	3,671.70	3,111.67
Hong Kong	2,662.08	2,855.28	3,101.20	5,036.57	4,257.58
South Korea	650.75	977.92	856.06	1,058.23	1,220.84
Taiwan	1,820.53	1,414.73	1,489.73	1,505.38	1,253.91
Singapore	2,219.34	2,144.38	2,469.68	2,194.80	1,588.35
Malaysia	1,729.93	2,117.17	2,140.95	1,964.52	1,366.74
China	2,055.27	3,502.16	3,814.57	4,508.63	4,593.66
Others	2,838.59	1,660.45	1,628.75	3,579.34	1,708.81

Sources: For 2004-2006: Department of Trade and Industry (available at: http://tradelinephil.dti.gov.ph/betp/trade_stat.expcod_sumprod)
For 2007-2008/1Q2009: National Statistics Office (available at www.census.gov.ph).

As expected, this rise in exports was also accompanied with a dramatic increase in job opportunities. In terms of employment, the sector contributed close to 23% of the total manufacturing employment which translates to 462,000 jobs in 2008. This is a big jump from 74,000 jobs generated in 1992 (see chart). The sector likewise commanded a sufficiently large amount of investments.

Table 3 Employment in Electronics Industry (In thousands)

	2001	2002	2003	2004	2005	2006	2007	2008
Total Employment in Manufacturing Sector	2047	2016	2280	2247	2275	2227	2282	2047
Manufacture of machinery and equipment, n.e.c.	54	44	66	40	61	53	50	
Manufacture of Radio, Television and Communication Equipment and Apparatus	157	182	200	229	269	270	306	
Manufacture of Medical, Precision and Optical Instruments, watches & clocks	33	21	18	23	23	16	13	
Total Employment in Electronics Industry	244	247	284	292	353	339	369	462
Growth Rate		1.23	14.98	2.82	20.89	-3.97	8.85	25.20
% Share to Total Manufacturing	11.92	12.25	12.46	13.00	15.52	15.22	16.17	22.57

Source: BOI; House of Representative, Congressional Planning and Budget Department.

3.2. The Philippine Innovation System

The electronics industry is a high technology industry that combines both manual operations and the use of state of the art equipment. It involves working on the smallest components, i.e. chips to the operation of big machines. Spanning the spectrum of the electronics value chain are low value added (assembly) to high value added (design) activities. The Philippine electronics industry is concentrated more on the low value segment of the supply chain, that is, assembly and testing, but involves the production of high technology outputs. At the floor level, operators need not be college graduates to be able to operate machines or manually assemble parts and components. Firms typically train their operators before or on the job. However, since high-technology inputs are involved, firms also require engineers and technicians in their manpower. Some has R&D units, production teams, and engineering departments. In this type of business units more highly skilled manpower is required -- college graduates, technical school graduates, licensed engineers.

It has often been claimed that there is disconnect between the number and quality of graduates of universities/technical schools and the manpower requirements of industry. Experts point to the weaknesses of the curriculum, the quality of education versus the quantity of board passers dichotomy, the lack of a prevailing innovative culture in the country, brain drain of engineers, among others.[3] If we look at standard indicators of scientific and technological capabilities, we find that the Philippines have much work to do in relation to the development of the national innovation system.

[3] Based on interviews with industry experts who represent the industry in policy discussions.

Table 4 R&D Indicators

	1992	1996	2002	2005
Total R&D Personnel (headcount)	15610	15837	9325	
No. of Scientists and Engineers (headcount)	9960	11215	7203	
Population Size (in million people)	65.34	71.9	80.16	
No. of R&D Personnel per million population	239	220	116	127
No. of Scientists and Engineers per million population	152	156	90	
GDP (current prices/ in million pesos)	1351559	2171922	3963873	
GNP (current prices/ in million pesos)	1375838	2261339	4218883	
Total R&D Expenditures (current prices/ in million pesos)	2940.5	4144.9	5769.75	6,326.74
R&D Expenditures as % of GDP	22%	19%	15%	12%
R&D Expenditures as % of GNP	21%	18%	14%	
Public R&D Expenditures (current prices/ in million pesos)	2088.8	2482.8	1615.59	1,622.09
and % to total	71%	60%	28%	25.6%
Private R&D Expenditures (current prices/ in million pesos)	851.7	1662.1	4154.16	3,961.93
and % to total	29%	40%	72%	62.6%
Per Capita R&D Expenditures (current prices, in thousand pesos)	188.4	261.7	618.7	

Note: In 2005, other sources of R&D expenditures were segregated from the general public and private categories such as higher education, private non-profit, from abroad, and not specified. The private category was reclassified as business.

Source: Department of Science & Technology.

The above data reveals that there has been a steady decline in R&D intensity spanning years 1992-2005. The percentage of expenditures devoted to R&D has significantly declined, from 0.22 percent of GDP in 1992, 0.19 in 1996, 0.15 in 2002, to a meager 0.12 percent in 2005. With the low R&D expenditure registered in 2005, the Department of Science and Technology's (DOST) target R&D expenditure of 0.30 percent of GDP by 2004 was not attained. Given this trend, DOST's target R&D expenditure of 1% of GDP by 2010 is unlikely to be realized.

Previous analyses on Philippine R&D point out the low share of private R&D expenditures and the need to significantly increase their share relative to the other sectors. From the available data covering 1992-1996, the public sector has always been the major contributor to total R&D expenditures in the country. In 2002, the trend significantly changed with the bulk of R&D expenditure coming from the private sector, claiming 72 percent to total R&D expenditure.

3.3. Government Policy for Upgrading and Innovation

The Philippine Constitution recognizes that S&T are essential for national development and progress and essentially dictates the components that should become part of the Philippine technology policy. In terms of a policy framework that sets the S&T objectives and detailed guidelines for attaining these, the country has had four major ones so far since 1986. Currently, the long-term National S&T Master Plan, 2002 to 2020 serves as the guiding framework for technology policy in the country. During its formulation, the Plan is said to have correctly diagnosed the problems faced by the S&T system such as low investment in R&D, poor quality of S&T education, lack of private sector participation in R&D, inadequate attention to the needs of the market as basis for R&D and innovation, and lack of technology transfer and commercialization.

In 2007, technology stakeholders including those coming from the government, industry, academe, and the private sector held an exhaustive forum that launched FilipINNOVATION, the brand for the country's national innovation system. In the first National Conference on Innovation, formal agreements were fostered, two of which included: the open technology and business incubation partnership between DOST and PEZA for start-up companies in the ICT industry and the work plan of the Engineering Research and Development for Technology Consortium (ERDT) comprised of seven engineering schools in the country and includes policy research and scholarship offerings as major activities. The FilipINNOVATION framework may yet jumpstart the need to develop a culture of innovation among the Filipinos. This is viewed to be essential to battling the protracted problems faced by the S&T system including prioritizing the channeling of resources for R&D pursuits that would respond to the needs of industry. Dialogues with industry players reveal that they would like to see a science and technology government agency teeming with scientists and PhD holders

that undertakes research and develop trailblazing technologies that can be applied and commercialized; and the establishment of common facilities including those for prototyping, calibration and testing. A stronger S&T system would inspire confidence among industry players and foster linkages and cooperation between knowledge stakeholders in the government and private firms.

Currently, the annual planning exercise of DOST involves the participation of industry as represented by various priority sectors. Since it has been dubbed, export winner, representatives from the electronics industry have been attending these consultations. Earlier this year, a similar forum was held wherein sectoral priorities for R&D were discussed including the necessary resources to bring them to fruition. During the discussions, it became apparent that there are synergies between and among the sectors represented in terms of the technology that they need. Aside from the opportunity of aligning research spending priorities better with these needs, the sectoral representatives were able to pinpoint possible areas for technological cooperation between them.[4]

In terms of policies to support industry development, the government direction is to continue attracting investments into the country, both local and foreign, through the provision of incentives as embodied in the Omnibus Investments Code of 1987 and the Special Economic Zone Act of 1995. In terms of an industry guiding framework, the government comes up with an annual Investment Priorities Plan (IPP) that clarifies entitlement to incentives; equity ownership; and equity requirement; and reiterates continued efforts for regional dispersal of industries. The IPP identifies the priority activities that will be pursued by the government as well as the selected industries that it

[4] This information was shared by an electronics industry insider and former head of an electronics industry association.

would aggressively promote.

Specific to the electronics industry, the Board of Investments (BOI) identified five areas that are essentially being pursued in support of Philippine electronics. For one, human resource development is being promoted through unified competency development; unified microelectronics program for MicroEd/ERDT university participants; and, IC design training program which is a collaborative undertaking with the Taiwanese authorities. Under industry development, there is a Test Development Program for MicroEd/ERDT university participants, and in the near future, conduct of Supply Chain Analysis of the Philippine Electronics Industry to be spearheaded by JICA. The BOI also claims to have an aggressive industry marketing campaign and that manufacturing excellence is being promoted through best practice sharing, people productivity programs and power/water conservation and reduction of cost of doing business in the country. According to BOI, they have been working closely with various electronics industry associations and support their activities (BOI, 2009).

The agency also works in tandem with the privately-run Advanced Research and Competency Development Institute (ARCDI), which provides highly technical and cost effective training and competency development support to semiconductor and electronics industry players. Its training modules are dedicated on specific competency areas which are claimed to be centered on industry requirements. According to the head of ARCDI, they will soon start pursuing the conduct of breakthrough/advanced research to push the technology frontier in the electronics industry in the Philippine context. Although the limited focus of ARCDI does not make it the counterpart of Taiwan's Industrial Technology Research Institute (ITRI), it is available and accessible to cater to the training needs of electronics firms.

On the supply side, the ERDT is playing a very important role. A consortium of six engineering colleges across the country, ERDT was able to secure a PhP3.5 billion

funding support from the government in 2007 covering three years of operations. According to Dean Rowena Cristina Guevarra, Executive Director of ERDT, their operations are aimed at filling the lack of R&D activities in the country and developing a critical mass of researchers, scientists and engineers (RSEs) with advanced degrees on programs vital to the national development. She attributes to the dearth in RSEs, with capabilities to translate R&D outputs into viable industries, undertake high impact research, share scientific knowledge, and set S&T directions, the slow growth of developing economies, like the Philippines. She noted that typically, developing countries have about 3.4 RSEs per 10,000 population while the Philippines only has 1.08. Dean Guevarra claims that it will take the country at least seven years to attain even the developing country average.

Further, Dean Guevarra mentioned that ERDT consults industry associations in their formulation of their R&D agenda, which enabled them to narrow down priorities into four areas: energy, environment and infrastructure, ICT, and semiconductor electronics. While the industry prefers that ERDT focus on manufacturing and failure analysis, it is the view of the latter that this is nearsighted and would only serve the immediate needs of the industry. In order to compete globally, R&D directions should include design, new materials and new electronics products. To compromise, the ERDT's research agenda for semiconductor electronics comprise five subfields: two are intended to address current needs and three for strategic purposes.

However, findings from previous studies indicate that many of the individual firms in CALABARZON were not aware of the government policies and program offerings that they can avail of. The DOST admits that there is a need to intensify its promotional campaigns to widely disseminate their various programs and technologies and truly reach their publics. It said that various promotional programs are underway to create

awareness among firms and the public in general about their programs.[5] Indeed, the DOST website and those of its attached agencies contain useful information about their technology promotion and commercialization programs. Perhaps, what would be more effective is for DOST and DTI to undertake firm-level discussions and consultations to disseminate their programs more effectively and strengthen interface with those they serve, in order to make their policies, programs and activities more responsive to the needs of industry.

Meanwhile, firm level studies like this paper is hoped to aid in putting forward the views of industry players on various issues that affect them and lay down the areas where closer interface and cooperation can be realized.

4. RESULTS OF THE CASE STUDY

The Philippine case study involved 10 firms: four are locally-owned, four are foreign-owned or affiliates of MNCs and two are joint venture firms. These 10 firms include some of the biggest names in the industry, particularly among Filipino-owned companies. They are a mix of lead and follower firms and all are located in the different economic zones in CALABARZON, but mainly in Cavite and Laguna. Half of these firms manufacture end-products, while the rest are into components assembly and testing. Table 5 provides a summary of the profiles of each firm covered by the case study.

Three of the 10 firms requested that the names of their firms not be disclosed. Many of them cautioned against mentioning the names of their actual customers and a firm even went to the extent of not divulging details with regard their plans to

[5] Lifted from the letter of Undersecretary Fortunato dela Pena responding to the formal written query sent to their office early 2009.

collaborate with a university. This paper is therefore, limited by the extent that the firms are willing to disclose details about their operations and their cooperative endeavors. However, most of them did not object to having their names cited in the paper.

Table 5 Profile of Case Study Firms

	Location	Ownership	Year Established	Business Activity	Respondent
M2 Fabrication, Inc.	Cavite Export Zone	Filipino	2006	Steel casing for electronics	Chief Executive Officer
Firm A	Laguna Techno Park	Filipino	1980	EMS	Chief Executive Officer
EMS Components Inc.	Laguna Techno Park	Filipino	2004	EMS	Director for Business Development
BELL Electronics Corp.	Carmelray Industrial Park, Laguna	Filipino	2000	Packaging for IC/semicon	Production Manager
REMEC Broadband Wireless International Inc.	Carmelray Industrial Park, Laguna	Joint Venture Filipino- American	2005	Microwave/RF units	President
Littelfuse Philippines, Inc.	LIMA Techno Park Batangas	American	1997	Electronics fuse	Human Resource Officer
Fujica Pacific Inc.	Carmona, Cavite	Joint Venture Filipino-Japanese	1995	Molded plastic products for electronics	Assistant General Manager
Exito Electronics Company. Ltd.	Carmona, Cavite	Taiwanese	1992	Extension cord	Production Department Head
Hayakawa Electronics Philippines Corporation	Cavite Export Zone	Japanese	1990	Wire harness	Human Resource Manager
Firm B	Cavite Export Zone	American French	1981 2006	UPS	President

It will be noted in Table 5 that four out of the 10 firms were relatively new as they were established only in the last decade. This is true for most of the locally-owned firms. The foreign firms meanwhile, found their way into the country during the 1990s, confirming the claim that foreign firms find the more liberalized policy environment attractive. In terms of the types of business activities these firms are specifically engaged in, it will be observed that not all of them are directly into electronics production. Some of these firms can be characterized as belonging to allied industries providing support to electronics. Though all of them are classified under the electronics industry, some of them easily fall other categories as well. Five of these firms were

interviewed under the auspices of the Semiconductor and Electronics Industries in the Philippines (SEIPI) from their list of regular members. The interviews with the other five firms were made possible by the National Statistics Office (NSO) drawn from the sample firms in the survey conducted in parallel to this study.

Effort was made to cover extensively both lead firms and followers to better explore instances of collaboration for purposes of innovation but at the time of the study, most of the MNCs are too busy to accommodate the interview.[6] Nevertheless, to the extent that was possible, the study was able to trace out links between some of the firms in the case study. Both EMS Components Inc. and Firm C are suppliers of Firm A which is a provider for key original equipment manufacturers (OEMs) in the computing, communications, consumer, industrial, automotive, and medical markets. On the other hand, M2 Fabrication was founded at the instance of Firm B that wanted to develop a local supplier to provide for their casing needs. Meanwhile, Exito Electronics Company Ltd was a former supplier to Hayakawa Electronics and presently, considers Firm B as customer for its products. To reiterate, it was unfortunate that at the time of the interviews, most of these firms declined to provide specific details on the nature of their relationships with both customers and suppliers, citing the highly competitive business environment they are in. Still, there are very useful insights that can be picked up from the results of the interviews. In particular, concrete examples of upgrading activities were elicited from these firms, which are summarized in Table 6.

[6] Inquiries made among Japanese firms were not successful since most of them are being audited by headquarters or there are on-going visits by their principals.

Table 6 Representative Examples of Industrial Upgrading/Innovation by Firms

M2 Fabrication, Inc.	Fastener for steel casing
Firm A	Automotive camera platform
EMS Components Inc.	Reconfiguration of operators' work space
BELL Electronics Corp.	Conversion of equipment for die attach process
REMEC Broadband Wireless International Inc.	Fully integrated product
Littelfuse Inc.	Fuse for specific upgraded end products
Fujica Pacific Inc.	Design of molds
Exito Electronics Company. Ltd.	Handling of assembly process
Hayakawa Electronics Philippines Corporation	Process improvement for ISO certification
Firm B	500 kva UPS

It will be noted that almost all of the firms in the case study were found to have had episodes of innovative activities in various forms and degree of technology involved. As utilized in this study, innovation (interchangeable with industrial upgrading or simply, upgrading here) is broadly viewed as involving the following: product innovation; process innovation; marketing, and organizational innovation. The next section summarizes the results of the interview of each firm in the case study.[7] In each of the cases, a visual representation of the network of linkages will be provided as it exists in CALABARZON, the Philippines (RP) and even across the world. In terms of the lines linking the firm with another, a solid line denotes that there is a strong linkage between the two parties especially when it comes to technology or knowledge transfer; while a broken line represents a weak relationship.

4.1. M2 Fabrication, Inc.

M2 Fabrication is a wholly owned Filipino company built in 2006 to engage in the sheet metal fabrication business that caters to the electronics and semiconductor industry. Their services include powder coating, silk screening, punch press, bending,

[7] It should be noted that the study made use of the common set of questions indicated in the guidelines distributed by the Working Group leader for the project.

and assemblies. M2 Fab for short, is part of Accutech Steel Service Center, a vertically integrated company of the Chan family who is into the steel business in the country for a long time. The mother company, founded in 1981, starts the chain with its importation of raw materials, which it then cut into sheets. These metal sheets are forwarded to the next company in the value-chain, Maxi Metal, which is into the manufacturing of tooling and fabricates the sheets before they can be converted into a box, bracket or frame. M2 Fab is the last stage in the chain bringing the fabricated sheets together and forming server racks.

According to the CEO, he brings in a different business model in the industry in the sense that when one of his company's needs parts, they build a company to fill the gap rather than purchase them from others. In essence, they become self-contained with internal mechanisms already put in place.

4.1.1. Linkages and Innovation

The CEO considers innovation as important in the electronics industry, in general and in his business, in particular since the turn over of electronics products is high. Basically, innovation in the steel business is not dynamic like in the electronics industry where one can create a certain product to fit a certain application. The steel industry is the backbone of the entire module. Though there is not much innovation involved in terms of the product itself, there are processes that have been changed to fit materials or some new part that has been introduced. According to him, these innovations do not really come from them but have been adapted from others. For instance, he mentioned that in the casing or cases that they produce for electronics firms, traditionally, all the screws and bolts are stamped into the metal case. In the last 10 years, one of the latest innovations related to casings came from the Americans. Pre-made fasteners are inserted onto the metal and clinches on it even without molding. These kinds of

products are very prevalent in the higher end metal cases. The CEO considers this innovation, albeit incremental, because it is the better solution and provides better reliability. Aside from these, other motivations for upgrading includes improvement in product quality; fulfillment of regulations and standards; improvement in the cycle time; improvement in production flexibility; and to enhance price competitiveness. The CEO himself monitors trends and developments in the industry as he is always on the look out to improve his companies. Along this line, he attends trade fairs locally and abroad.

Related to this, improvements in organizational processes are also being done regularly and in fact, the companies under him have adopted the 5S and have undergone ISO certification. According to the CEO, these are important in order to cope with internationally-accepted standards, norms and best practices. When it comes to internal strategies to achieve upgrading, the acquisition of machinery and equipment in connection with the innovation was mentioned. In fact, in the 80s and the 90s, the CEO said that his company introduced new machines in the industry.

In the particular upgrading example earlier cited, the CEO mentioned the company of his sister as the one that introduced the innovation. He considers his affiliates within his vertically integrated company as partners, and so are his customers. They are all located within the same industrial area in CALABARZON. It is strategic for the company to locate near customers as in the case of M2 Fab which was established in the Cavite Export Zone to be in the proximity of Firm B. It should be noted that it was Firm B that encouraged the CEO to put up a facility to respond to its needs, leading to the establishment of M2 Fab. Although M2 Fab was created for Firm B, the other firms affiliated with the mother company also cater for or supply its needs. Accutech provides the raw materials to Maxi Metal and M2 Fab and even to its competitors to form products intended for Firm B. The latter puts in the electronics in the casing to become an electronics module. When the final products are shipped out, some also

finds their way back to the M2 Fab assembly area, which packages the products before shipping out. Thus for the CEO, his companies are able to cater to the needs of Firm B in one full circle. Figure 1 provides a visual representation of the linkages M2 Fab has within its production network.

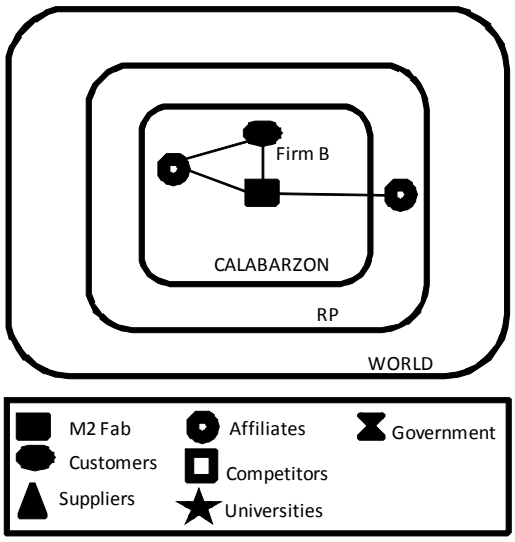

Figure 1 M2 Fabrication Linkages

As partners, the company engages in informal information exchanges with his affiliates and customers, mentioning that the sales people from his sister's company often go around introducing products. As he considers his customers as lifeline, the CEO pointed out that regular communication is important. The nature of collaboration may at first be institutional, but as the relationship becomes more frequent and regular, it becomes more personal. The CEO admitted dispatching engineers to his partners and that his companies also receive engineers from them. This is such a regular occurrence that these engineers have already established good interpersonal relations.

4.1.2. Obstacles to Innovation and Collaboration

In terms of obstacles to collaboration, the CEO mentioned that contractual

agreements are difficult to enforce on the part of the customers. He also cited the difference in time horizon, in terms of what he perceives as right timing vis-à-vis his customers and highlighted that time matching is important, especially when upfront investments are involved. When it comes to obstacles to innovation, the CEO cited the high cost of technical manpower. As for the government's role, he mentioned that it creates a lot of road blocks to running businesses efficiently, which is true for both the national and local governments.

4.2.Firm A

Firm A was established in 1980 as a joint venture between one of the largest family-run companies in the Philippines and a small integrated circuits assembler. With almost 30 years of experience in the industry, Firm A has an established expertise in comprehensive manufacturing capabilities and higher value services for storage device, communications, industrial, consumer, and automotive electronics markets. Firm A is substantially Filipino-owned (about 99%), with the employees owning about close to 9%-10% stock ownership. The company's facilities in the Philippines are located in Laguna and Cebu offering a wide range of services such as printed circuit boards assembly (PCBA), Flip chip assembly, Box build, Sub-assembly, and Enclosure system manufacturing.

Firm A originally went into the business to take advantage of the outsourcing trend driven by US firms in the 80s. Specifically, they were outsourcing integrated circuits manufacturing. The company shifted to sub-assembly manufacturing when it was the Japanese firms' turn to outsource this segment of their production chain. In 1998, the company decided to make investments in technology and engineering, and started a small R&D engineering support group. It was in the earlier part of 2000 when the firm charted a new course and to not just try to compete and grow locally, but grow globally.

A lot of internal changes ensued, putting infrastructure both front to back, and standardized and optimized a lot of their operating procedures and systems. It opened up real offices outside of the country to drive sales.

By 2005, when it has become financially strong enough, it started acquiring new companies. It was sort of historical, with a Filipino company buying assets such as a US-based company, setting its footprint in the US and expanding its manufacturing site in the Philippines. This is when the firm truly considered itself a global company. Key to its complete service is flexibility and responsiveness to customer needs, and respect for customers' intellectual property rights. It is claimed that OEMs can leverage the firm's world-class quality and productivity systems. At present, Firm A has a prototyping and engineering center in North America located in Tustin, California. Through this facility, the firm has acquired three US patents for advanced manufacturing. One of these innovative method speeds up the chip assembly process while efficiently maintaining control over flux application. The company has also acquired an established EMS firm in Singapore in 2006 that enabled it to possess additional original design manufacturing (ODM) capabilities in power electronics. This acquisition gave the firm access to additional manufacturing facilities in China, Singapore and the Philippines. In the same year, Firm A acquired a Philippine-based engineering-oriented test systems integrator, developed an engineering support center in Japan and a process management group in Europe to meet the needs of a tier one European automotive original equipment manufacturer (OEM).

The globalization strategy of Firm A has resulted in: (1) Eleven (11) manufacturing plants worldwide, with plans for expansion; (2) Total production area of more than 1.9 million square feet; (3) Capability for both low volume-high mix and high volume-low mix manufacturing; and (4) Over 100 Surface Mount Technology (SMT) lines using the latest equipment.

4.2.1. Linkages and Innovation

In view of rapid technological changes and volatile market conditions intensifying competition among electronics companies, Firm A is compelled to continuously upgrade its skills and diversify its markets. Needless to say, the firm considers upgrading or innovation as important. A recent example of upgrading in the firm was the development of a camera platform to respond to the increasing need for driver assistance systems and electronic content in cars, as well as the growing need for safety regulations in the European Union and the US. This is considered by the CEO as an introduction of a new product/service and in terms of degree, radical innovation as it implies doing something completely new to the firm. The top three motivations for undertaking this upgrading effort are to increase market share, learn about new technology, and for diversification. For this particular example, the firm's strategy was to co-develop it with an imaging technology expert. Contributing to this innovation are external partners- the imaging technology expert; the firm's in-house R&D department and business units within the firm.

The external partner is a foreign owned company engaged in other industries located in California, USA. Needless to say, this particular partner is outside CALABARZON where Firm A's headquarters is located. Their collaboration mode is through technology assistance having been a partner for more than one year. The firm does not dispatch engineers to this partner, and so does the latter.

However, Firm A also considers its customers as important partners for upgrading. The CEO mentioned that his average tenure with customers is seven years. Many of these customers are also locators of the industrial zone where Firm A is. Frequency of collaboration with these partners is regular and occurs through corporate roadmap sharing and development. This interface is considered important because the

manufacturing capability of the firm should match the plans and strategies of the customers in the future.

In its official company profile, Firm A claims to also have strategic alliances with other global EMS companies in the US, Europe and in the Philippines. They may be competitors at certain levels but Firm A noted that their collaboration complement the firm's competencies, enabling them to explore subcontracting opportunities and allowing these firms to be its prototyping facilities for foreign markets.

Meanwhile, the President of Firm A said that they also engage local universities for technology dialogues and conduct of symposia. The firm also trains and uses university professors for specific projects. These universities include the University of the Philippines, De La Salle University and Ateneo de Manila University. These are the top three universities in the country with the first two having campuses in CALABARZON. Firm A also collaborates with other schools in the region such as Lyceum University in the South and Technological University of the Philippines. They have institutional cooperation/arrangements including training (both ways) and internships in the firm. If there is one impediment to deepening collaboration with universities, it is lack of technological exposure and practical applications. Firm A also has direct liaison with the Massachusetts Institute of Technology in the US. Figure 2 below represents this extensive web of network by Firm A.

In his personal capacity, the CEO is often invited in consultative panels to discuss the status and future of the industry; sits in various Committees like the Philippines' Competitiveness Council; chairs the ARCDI; a trustee of the SEIPI; and, an adviser to engineering departments of technical universities in the country.

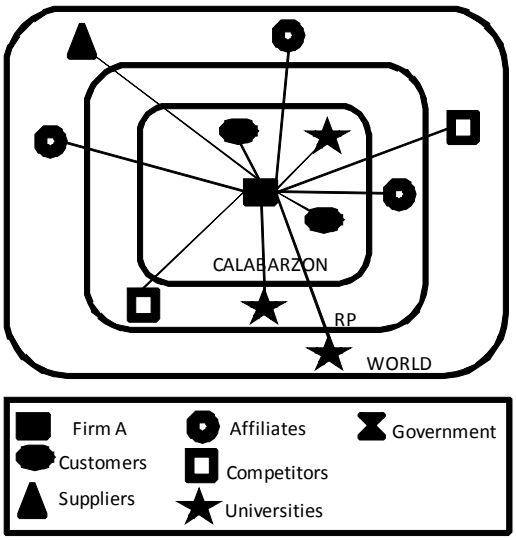

Figure 2 Firm A Linkages

4.2.2. Obstacles to Innovation and Collaboration

In pursuing the particular example of upgrading cited, Firm A did not encounter any obstacles to collaboration. Hence, the firm did not need any public support to facilitate the collaboration. In terms of internal obstacles to upgrading, lack of information on technology was cited. As for the external factor hindering upgrading, the culprit was lack of sources of market information.

4.3.EMS Components Assembly Inc.

EMS Components Assembly, Inc. (EMS-CAI) is a locally-based, 100% Filipino-owned contract manufacturer whose main charter is to provide cost-effective, efficient solutions to the growing global electronic manufacturing subcontracting market. Its goal is to become a market leader geared towards low production cost with the highest quality level. It was established in 2004 by a father and son team whose motivation is less driven by the profit motive but more so by proving a point that a Filipino company can do what a Chinese company can. In order to capture that contract which Firm A is

planning to sub-contract to China, EMS was established with only 90 operators and three managers in Sta. Rosa, Laguna. After only five years in the business, EMS has grown and evolved as "the choice manufacturing assembler" of electronics products.

The founder of EMS is Francis Ferrer who is fondly known in the industry as the "Father of Philippine electronics." He was President of Firm A for many years and was head of the SEIPI. When he retired from Firm A, he became board member of PEZA and the BOI. All these stints indicate that EMS was founded on the basis of experience and knowledge of the industry dynamics.

The main business of EMS is electronic assembly for OEMs, ODMs and even other electronics manufacturing services companies. Its array of customers, in addition to Firm A, includes Panasonic, Toshiba, Sanyo, Kisho Sakata Electronics, among others. Although EMS takes on labor-intensive jobs, the company considers itself as high technology, the principle being that manual work can be done in a high-technology way. Through close monitoring of quality and productivity, sophistication is added to manual operations.

4.3.1. Linkages and Innovation

The interviewee was the son of the company's founder who serves as Director for Business Development. He claimed that yes, innovation is important for EMS. This despite the fact that they are on the lower level tier of electronics manufacturing that just accepts the specifications of its OEM-customers in order to assemble intermediate products. For example, EMS does actual assembly of DVD players, while for an mp3 brand, what the company does is limited to a particular electronic component before it gets passed on to another company. Though it does not produce its own products, innovation for EMS is important in order to maintain its leg-up over the competition. It is able to maintain its edge by constantly being better and faster than its customers and

its competitors. So far, EMS has been able to deliver 99% good products from the materials consigned to it, which translates to 1% loss rate. This implies materials savings on the part of the customer. The Director mentioned that the company's upgrading efforts are essentially directed towards improving the work space on the floor to make it more operator-friendly and line-friendly. Hence, it does process innovation that is incremental in degree and produces innovations that are new to the firm. The Director said that what they do is a combination of process innovation and improvement of jigs and fixtures, fixing it in such a way that one jig can already do multiple functions. According to the Director, the specifications may come from the customers but that is only half of the equation. The other half involves the company's injection of its own design and innovation, working on what the customer has provided and then improving on it.

With most of its customers and suppliers located in CALABARZON, EMS decided to locate its headquarters and assembly factory in Laguna Technopark. It is in the same industrial zone where customers like Firm A and Panasonic are located.

In terms of motivation for upgrading, the Director points to the need to remain competitive and be better than the company's customers because otherwise, they will just do the assembly themselves. The contributors to upgrading are the company's internal R&D unit composed of six people, its product development team with seven and other internal departments or individual business units that have two engineers on-board to assist in improving the process. In fact, the upgrading example cited by the Director was an idea that came from an operator. Encouraged by the culture prevailing in the company, the operator made a suggestion related to making his/her workspace be more productive. The company's R&D unit then turned the idea into fruition. In this example, the operator suggested modifying the microscope being used by operators in order to have more elbow room and better reach of parts being assembled. This idea

turned into reality with the improved workspaces for the operators.

When it comes to partners for upgrading, the Director considers firms in the same business group, customers and the industry association – SEIPI. Except for SEIPI, all of the customers and suppliers of EMS are located within CALABARZON. When it comes to collaboration mode, EMS and its partners have informal information exchange; human resource development and exchange of technical personnel.

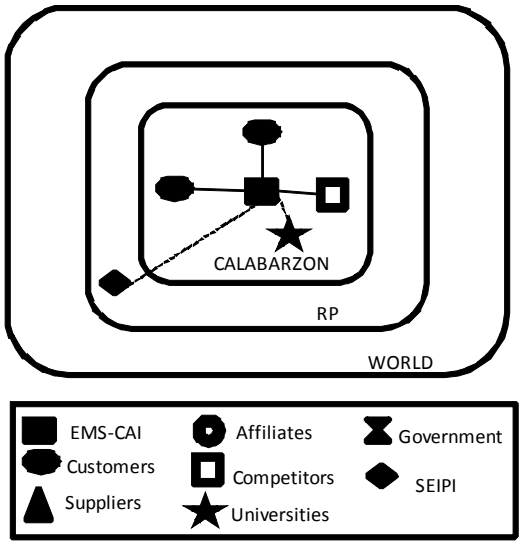

Figure 3 EMS-CAI Linkages

In terms of duration, average length of the relationship is about four years, with EMS in existence only for about five years. In terms of frequency of collaboration, the interface is fairly regular with basis of collaboration bordering on personal already. The Director mentioned that in strategic planning sessions of its customers, EMS is always included in order to find out the directions of the customers and how EMS can respond to them and the types of improvements/upgrading that may be required. Exchanges of engineers also do happen between EMS and its customers. What they do is to exchange technical information as well as on improvements. The EMS engineers

inform their counterparts about their business status, while the latter give them information about their company's short term plans or if there is a new product model so EMS could prepare for it. Engineers are also sent to SEIPI to participate in training programs.

4.3.2. Obstacles to Innovation and Collaboration

When it comes to obstacles for collaboration, the Director pointed to intellectual property issues as a concern limiting the extent of technical information that partner firms are willing to share. As for internal factors that impede innovation, the Director pointed to choices such as perceived risks and costs too high; limited financial resources; lack of information on technology and on markets. External factors that hinder innovation are lack of qualified personnel, inadequate support services and lack of government support. Collaborations are able to mitigate some of the obstacles when it comes to alleviating the problem of lack of personnel. In its own terms, EMS tries to develop its own skills requirements through its cadetship program, where it recruits fresh engineering graduates and trains them on the job for six months. Though the company is not able to hire everyone on board, they get easily picked up by other companies.

EMS to some extent collaborates with universities but mainly to speak in classes and to accommodate OJTs. The Director pointed to the problem of matching industry needs with the manpower that comes out from these universities.

As for the government, the Director lauds the incentives given to companies through PEZA but hopes that the government can work on having one common strategy for electronics alone and better equipped facilities that are affordable for the use of industry players.

4.4.Remec Broadband Wireless International Inc.

The President of Remec Broadband Wireless International Inc. (RBWI) and his company is a success story that is highly regarded in the industry. The head of RBWI is an engineer that tried his luck in Silicon Valley in the US, got trained technically and then came back to the Philippines with a desire to build his own company. The first company that he founded together with fellow Asians and Filipino-Americans in 1995 was called Pacific Microwave Corporation that was the country's first and only provider of manufacturing and test services of radio frequency (RF) and microwave devices. In time, the company grew and captured a global market share including customers in the US, Europe and Israel. By 2000, the company was attractive enough to merit an offer from REMEC, Inc. (an American, US-based company) and was acquired to become REMEC Manufacturing Philippines, Inc. Following a change of management, the company's outdoor unit (ODU) and transceiver business was bought by the group of Mr. Bonifacio and was renamed, REMEC Broadband Wireless International (RBWI).

RBWI was formed officially in 2005 and located its manufacturing facility in Carmelray Industrial Park in Laguna. Five years hence, RBWI is a global leader in the wireless broadband revolution. Its ODU is the only commercially successful off-the-shelf ODU product in the market, saving millions of dollars in product, R&D, and manufacturing costs for OEMs, which otherwise would have to develop the product themselves. RBWI also accepts outsource manufacturing of complex components, sub-systems, and systems alongside its own world-class products. The company has presence in San Diego, California and design centers in the US, Canada and soon in the Philippines. Being a global company, it has sales offices in Milan, Italy; Beijing and Shenzhen in China. The President is investing in training people in the US for the eventual establishment of an R&D facility in the country. He admitted that the company does not need another facility like this but it had always been his dream to

establish an R&D company in the Philippines as his contribution for jumpstarting the development of technological capabilities in the country. Moreover, having an R&D facility close to manufacturing capabilities has its advantages.

RBWI is a joint venture with majority shares coming from Filipinos and the rest by American investors. The top executive of the company does not consider ownership of RBWI as a joint venture though, insisting that it is one company with groups of investors representing two nationalities. The fully integrated ODU is the company's main product. It is an infrastructure facility that is being put up in towers and cell sites to enable transmittal of RF. Although the company develops and builds the product, they are not considered as an OBM as their customers in the likes of Motorola and Nokia put their own brand into it. However, the company owns a patent to the product being their own design.

4.4.1. Linkages and Innovation

Being a high-technology company, RWBI considers innovation as very important. The President cited two examples of recent innovation that the company has done. One is the development of the ODU itself, a product innovation, and the other, the adoption of the 6-sigma system, a process-innovation. Both are considered incremental innovation since they are both improvements to increasing systems. In particular, the fully integrated ODU was an upgrade from the former product that requires a different unit for every RF, while the 6-sigma system is a value system that aims to improve existing organizational systems. The improved product caused cost reductions, enabling RBWI to quote a substantially lower price to the advantage of its customers. The President considers his ODU as something that is new to the world, while the value system is not.

There is only one motivation for the upgrading and that is, to reduce production

costs/materials energy. The company made use of its intramural capabilities to develop the product. Indeed, the firm's in-house R&D department plays the major role in product development and design. It maintains its facility in the US in order to be near the market. Although there are instances when customers change their interface to make use of RBW's products, the company also comes up with products based on the design and specifications of its customers.

As for its partners for upgrading/innovation, RBWI considers its tier one customers as just that. Since they demand high standards for their orders, RBWI has to be responsive and up to par. For example, if the customer demands zero defects but the average in the company is 5%, the company has to work on upgrading its capabilities to be able to respond to customer demands.

RBWI considers their suppliers as partners too. In fact, every January the company holds a Supplier Day- for both local and foreign suppliers. The company confers awards to best suppliers, while it also serves as venue for sharing business outlook. Like their customers as partners, the company also works with their suppliers to ensure good quality inputs. Frequency of collaboration with suppliers is every quarter as RBWI audits them under its supplier quality under RBWI's Engineering group.

These partners for upgrading are not within the proximity of RBWI as the most important customer is in China, while the supplier-partners are both the locally-owned and foreign-based ones. When it comes to modes of collaboration, RBWI engages in joint R&D projects with its suppliers for new devices, while technology assistance is another way. Frequency of collaboration was indicated to be regular for both partners on an institutional basis. Mutual dispatch of engineers is likewise being done. Meanwhile, RBWI has had collaborations with training centers and universities in Laguna for manpower upgrading, on the job training and training of faculty from the University of the Philippines to learn about the manufacturing process in the company.

The firm has also sponsored or has granted scholarship to deserving students through SEIPI's program.

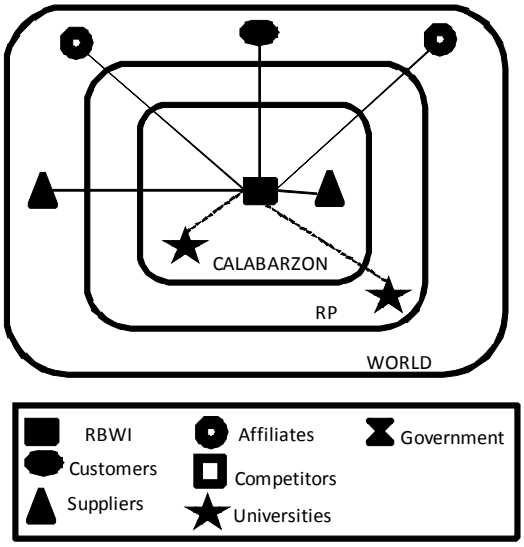

Figure 4 RBWI Linkages

4.4.2. Obstacles to Innovation and Collaboration

The President did not find any obstacles in collaboration indicating that hindering factors are not applicable to RBWI. He did not mention any obstacles to upgrading as well, both internal and external, since the company is able to overcome difficulties. For instance, lack of technical skills at the local level is addressed by the training provided by capable R&D personnel and engineers based in the US. Moreover, Filipino manpower possesses the minimum technical skill requirements, making them trainable and easily adaptable to new technologies.

The President of the company lauds the government for enabling the establishment of industrial zones in the country since business transactions like exportation and importation were simplified.

4.5.BELL Electronics Corporation

BELL Electronics Corporation, a wholly Filipino owned company was established in 2000 as an assembly and test subcontracting house for optoelectronics and sensor devices. It was built by a group of engineers and former employees of a well-established electronics company also located within CALABARZON.

Initially the company focused its resources in metal can packaging for electronics IC. Located in Carmelray Industrial Park in Laguna, BELL is a small firm that indirectly exports to the US, Europe, Singapore, and Taiwan. Its package line started with only three types when it was established, before growing to 20 types of packages. Similar to other Filipino electronics firms engaged in assembly and testing, the main goal guiding the operations of BELL is giving the best possible value for money for its customer/s by providing the highest attainable quality product at the shortest possible time while ensuring the best customer care. Hence, the two main objectives here are quality and speed, implemented on the floor by its team of multitasking operators. The firm boasts of a 2% reject rate in its production, which is an indicator of the quality level the company is able to crunch out. These operators are trained by the company for three months.

4.5.1. Linkages and Innovation

According to the Production Manager, who is well-versed on the operations of the company, BELL considers upgrading or innovation as important. As a subcontracting company, the focus of their upgrading efforts is on the production process and in making sure that the equipment they have would enable them to fulfill customer specifications. It is necessary for the company to have flexibility in their operations in order for them to customize equipment according to their production needs. As an example, the Production Manager cited that the firm had to convert different types of

equipment to enable them to do die attach processing. This upgrading in terms of the conversion of equipment for other purposes was undertaken, not by an R&D unit which the firm does not have, but by a team of engineers. In fact, they have instituted the concept of failure analysis to respond to critical problems on the floor. They also have control charts that enable them to monitor their operators and the production process so that they can immediately take action once problems are identified. In the particular upgrading example cited by the Production Manager, incremental innovation was the degree achieved. It was apparently innovative enough that the upgrading was considered not only new to the firm but also new to the market where the firm is operating. Figure 5 traces out the linkages that the firm has for upgrading/innovation.

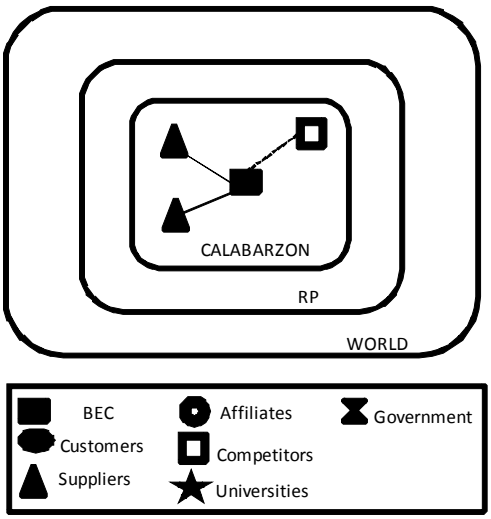

Figure 5 Bell Electronics, Corp. Linkages

The company's upgrading efforts are motivated by the need to improve production flexibility and reduce production costs because the improvements did away with procurement of equipment. The firm's internal strategy is to tap its capabilities within the company, particularly its engineering department. Hence, the Production Manager

considers their engineers as the main contributor to the innovation. As regards partners for technological upgrading, the Production Manager points to their vendors or locally owned suppliers. He acknowledged that because they are able to go around places and pick up technological information, the firm is able to generate technical information from these suppliers as well. These local suppliers operate from Laguna, which makes them proximate to the firm. The collaboration mode between and among the partners is technology assistance, and frequency of collaboration is regular, as in once a week. The partnership arrangement is institutional in nature and they dispatch engineers to each other. The main suppliers are required to be ISO certified. It was noted that the technology or technical information acquired is embedded in the equipment provided by the suppliers. Though not really considered as partner for upgrading, the firm has a healthy, informal relationship with its competitors. The Production Manager said that at a certain level, they do have link-ups with their competitors including materials exchange and sharing of information.

4.5.2. Obstacles to Innovation and Collaboration

In terms of hindrances to collaboration, the Production Manager did not cite any, but when it comes to internal factors serving as obstacles for upgrading, he pointed to the limited financial resources that can be set aside for this effort. As for external factors on the same, lack of customer interests in innovation was cited. As assembler of intermediate products, the firm relies on the dynamism of its customers; otherwise, it just performs what is required as per specifications. The Production Manager did not mention any public policy or program that was helpful either for facilitating collaboration or for solving obstacles for innovation.

When it comes to human resources, the Production Manager opined that quantity is a non-issue. Rather, the main concern is the quality of manpower, particularly of

engineers.

4.6.Hayakawa Electronics Philippines Corporation

A member of the Hayakawa Group of Companies of Japan, Hayakawa Electronics Philippines Corporation (HEPC) started out in 1990. Founded as a separate entity and located at the Cavite Export Zone, HEPC's main customer is the mother company itself and conducts wire harness assembly for small appliances and automobiles. HEPC is one of the two companies established in the Philippines by the Hayakawa Group, with the other one engaged in the components business. HEPC has undergone upgrading when it comes to the application of assembled wire harnesses, starting out with assembling wire harnesses for small appliances and now, for automobiles and vending machines. It was pointed out that the firm could not just simply upgrade, it has to make sure that it follows adequate standards in production since safety is a major concern when it comes to product applications.

4.6.1. Linkages and Innovation

In fact, the upgrading in relation to wire harness assembly for automobile was the example provided by HEPC. The Human Resource Manager interviewed mentioned that special care and attention has to be given in this venture since the safety of passengers is the primordial concern. Needless to say, the company has to upgrade its capabilities to be able to fulfill the stringent requirements equivalent to an ISO or TS. Since HEPC's production is labor intensive, it goes to show that innovation has to be directed towards skills upgrading. For this particular example, the Manager cited adoption of new production method and substantial organizational change as the types of upgrading in relation to the company's venture towards wire harness assembly for automobile. It can be regarded as incremental innovation that was new to the firm. She

cited several stimulants for the innovation namely, replacement of products or model changes, improvement of product quality, opening up of new markets, compliance with regulations and standards, improvement of cycle time, decrease delivery lead time, improvement of production flexibility, reduction of production cost, improve work conditions for employees, learn about new technology, enhance price competitiveness, and reduce environment effects such as lead free materials.

When it comes to the firm's strategies to realize the upgrading effort, the following were indicated: acquisition of machinery and equipment in connection with process modification; training and market introduction of innovations. For the particular example cited, the firm considers its in-house department, in particular Design and Development (D&D), and other internal departments as contributors to the upgrading. The D&D unit has to check the applicability or manufacturability of the proposed upgrade as well as check if it is suited to customer requirements.

As to who the firm considers as partners for upgrading, the Manager cited two particular examples – customer and supplier. The former pertains to the Hayakawa mother company. It is considered to be both located within the agglomeration and across or outside the industrial area where HEPC is; while its partner-supplier is not located within the agglomeration. The collaboration modes adopted for both partners were said to be informal information exchange, joint D&D projects, contract research, technology assistance, and exchange of technical personnel including engineers. The duration of collaboration for both is 19 years and frequency of collaboration that is both institutional and personal, is regular. HEPC also has linkages with foreign-owned suppliers; firms in the same business group particularly its Mother Company and affiliates, other customers, and also, competitors at certain levels. It also has links with universities but only in terms of sending a list of students studying in related programs.

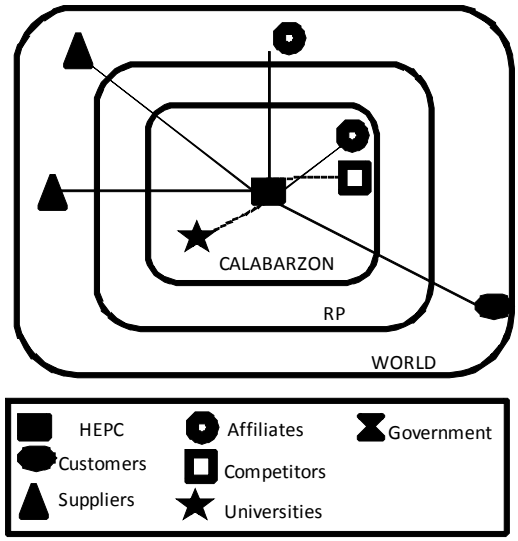

Figure 6 Hayakawa Electronics Philippines, Corp. Linkages

4.6.2. Obstacles to Innovation and Upgrading

Obstacles to collaboration that was mentioned by the Manager were difference in time horizon in the literal sense and limitations caused by intellectual policy issues. As for hindrances to innovation, internal factors such as perceived risk too high and perceived cost too high as the major ones. However, collaboration can mitigate such obstacles through mutual testing and liability sharing. Meanwhile, an external turn off factor to innovation is lack of customer interests in innovation especially since the specifications and requirements of the work required come from them.

4.7.Firm B

Firm B, an American company, provides protection against many of the primary causes of data loss, hardware damage and downtime. Founded in 1981, Firm B is a leading provider of global, end-to-end AC and DC-based back-up power products and services, which include surge suppressors, uninterruptible power supplies (UPS), power conditioning equipment, power management software, and DC power systems as well

as precision cooling equipment. Firm B's corporate offices are located in West Kingston, Rhode Island. The company has sales offices throughout the world and manufacturing facilities in the U.S., Ireland, Switzerland, Denmark, Philippines, China, India, and Brazil.

The interview was granted by the President of Firm B, an American. The facility in the Philippines is the largest manufacturing center of Firm B in the world. Initially, the company does not have offshore manufacturing in Asia not until it decided to establish its presence here in Manila. Instead of acquiring another company, it was decided to set up its own.

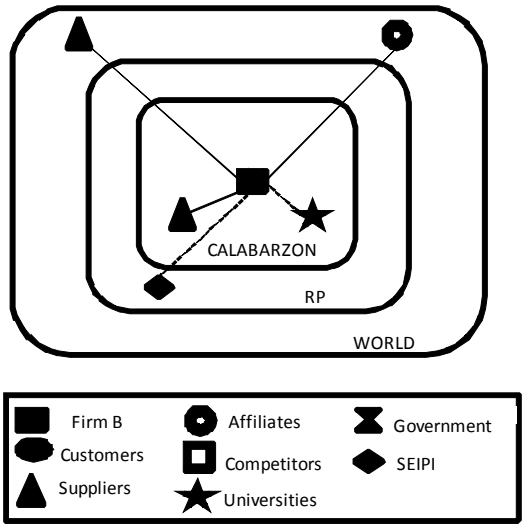

Figure 7 Firm B Linkages

4.7.1. Linkages and Innovation

Firm B's President admitted that upgrading/innovation is important to the company and cited the introduction of the 500kva UPS as example of this. As innovation type, this upgrading effort enables them to introduce new product or service; adopt a new production method; secure new supplier/new materials; and, substantial organizational

change. The firm considered their recent effort as neither incremental or substantive and opted to provide for so called, disruptive technologies. The motivations for upgrading were improved product quality and opening up of new markets. This enabled Firm B to adopt internal strategies in implementing the innovation utilizing intramural/in-house R&D; training and, reverse engineering. In the upgrading example earlier citer, Firm B considers vendors as one of those who gave substantial contribution to Firm B. Also added were the firm's internal departments.

4.7.2. Obstacles to Innovation and Collaboration

As for obstacles for collaboration and innovation, the President cited the firm's capability to innovate on its own and the difficulties in looking at the difference in time horizon.

Meanwhile, among the many obstacles to innovation, two were identified namely, perceived cost too high and others. Among the external factors, lack of qualified personnel was pinpointed as a hindrance to upgrading.

4.8.LITTELFUSE PHILIPPINES, INC.

Littelfuse Philippines, Inc. is a manufacturing facility of Littelfuse, an American company with headquarters in Chicago. The Philippine facility is located in LIMA Industrial Park in Batangas and manufactures products, i.e. fuse, for application in the electronics industry like in cellphones, teleconferencing equipment, laptops, among others. Littelfuse is the worldwide leader in circuit protection products and solutions, with a comprehensive portfolio backed by industry leading technical support, design, and manufacturing expertise and having significant investments in R&D and distribution. The products of Littelfuse are vital components in virtually every product that uses critical energy, including automobiles, computers, consumer electronics,

handheld devices, industrial equipment, and telecom/datacom circuits.

Representing the company was the Human Resource Officer who proved to be very knowledgeable about the operations of the company. She acknowledged that upgrading/innovation is very important for the company. Product innovation is meant to align with customer needs and requirements, while process innovation is done in a backdrop of being a lean company, to be able to shorten production without sacrificing quality. In fact, the firm has ISO certifications and has been practicing the 6-sigma value system for a long time.

4.8.1. Linkages and Innovation

As representative example of upgrading efforts, the Officer cited the need to customize the firm's fuse as a response to the introduction of new cellphone models by its client. It was mentioned that each model sometimes requires a different kind of circuit protection. This type of upgrading was related to the introduction of new product but an incremental innovation since there is only a need to improve the same product but customized to the pressing needs of the customer. Since the upgraded product can be considered new, it is a novelty in the market where the firms are operating in that regard. The motivation for the upgrade is to replace the product being phased out or being upgraded, to improve product quality, extend the product range, and open up new markets. Meanwhile, additional information was provided like when it comes to the aim of getting certification, the motivation for upgrading is the fulfillment of regulations and standards, while there is another set of rationale when it comes to process innovation. As for the firm's strategy in relation to its upgrading efforts, the company relies upon its intramural/in-house R&D efforts; acquisition of other external knowledge such as licenses to use intellectual property; training; and basic design. The contributors to this type of upgrading were its in-house R&D unit as well as other

departments like process engineers and even from the operators.

Littelfuse's partners for innovation are its customers and suppliers, both local and foreign owned. However, these customers and suppliers are mostly outside of the agglomeration. In addition to informal information exchange where the customer shares market information, exchange of technical personnel was also mentioned. The frequency of collaboration to its partners are regular and on an institutional basis. While the firm dispatches engineers to its partner customers and suppliers, the firm does not receive engineers from them.

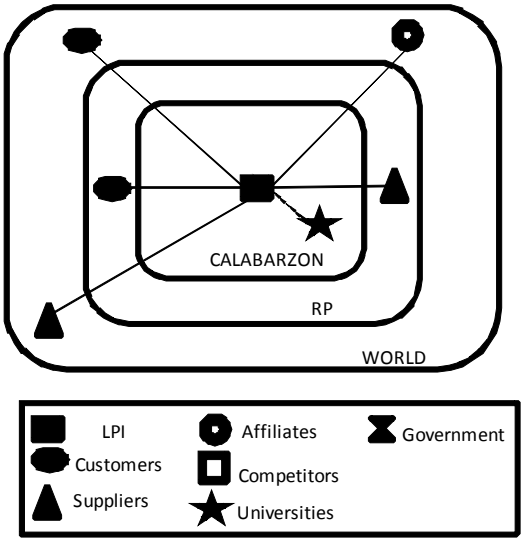

Figure 8 Littelfuse Philippines, Inc Linkages

The firm likewise engages other parties in various types of activities, not necessarily related to innovation pursuits. For one, Littelfuse has a two-way relationship with universities located in CALABARZON such as Batangas State University, among others. The firm accommodates on-the-job-trainees from universities and employees from the firm serve as resource speakers in their classes. In a similar manner, the firm also engages consultants to become technical resource persons for them.

4.8.2. Obstacles to Innovation and Collaboration

The main obstacle to collaboration as pointed out by the Officer is the so called, intellectual property issues, hindering further exchange of technical information. As for obstacles for upgrading, the Officer did not identify any since the firm is able to cope with both internal and external factors. She added that they regularly set aside a budget for R&D and the firm is aware of the possible risks.

4.9.Firm C

Firm C is a joint venture company between a large family-owned Filipino company, and a Japanese company for the manufacture of high precision injected molded plastic products for electronics. It was incorporated in 1995 and started commercial operation in 1996. Located outside of PEZA zones, Firm C is registered with the BOI. It is claimed that the company was founded to respond to the needs of Toshiba for plastic frame/products. Though it was unfortunate that the DVD-rom operation of the latter closed down, Fujica was able to pick up other customers like Firm A and Japanese firms as subcontractor.

The company acquired additional units of injection molding machines in order to increase its capability and capacity for a total of 16 injection molding machines complete with accessories three years after it was founded. By 2008, the company can already count twenty (20) machines.

4.9.1. Linkages and Innovation

The interviewee was the Assistant General Manager of the company. According to him, since they are engaged in plastics processing or hi-precision injection molding in support of electronics firms and their products, and they are dependent on the molds

designed and supplied by their customers, upgrading is not really that important to them. The company's upgrading if any, is limited to fixing their equipment to adapt to the needs of their customers. However, during the course of the interview and further exploration into the plant yielded the observation that some of the firm's employees are venturing into mold design. The fact that they are into mold or product development as well as into equipment upgrading or adaptation, then it can be considered that the firm is also into innovative activities. These are however, not a priority at the moment and largely informal. Due to this, collaboration is also not present when it comes to upgrading/innovation concerns. Nevertheless, engagement with local universities was traced although their interaction is limited to the accommodation of on-the-job trainees in the firm.

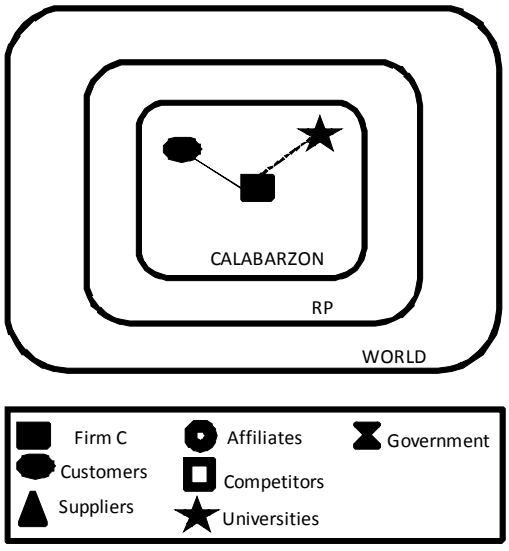

Figure 9 Firm C Linkages

The inclusion of this firm in the case study was continued to be able to provide a counter-example to the others and in order to derive insights into why there are firms in the electronics industry that do not do R&D.

4.10. EXITO ELECTRONICS COMPANY PHILIPPINES, INC.

Exito Electronics Company Philippines, Inc. is a foreign investment corporation set up in 1991 as a manufacturing firm, which is wholly Taiwanese in ownership.[8] The company's products are export-bound comprising of indoors and outdoors- use extension cord, electrical wires and cables, communication and audio/video cables. Its operations are highly automated in keeping with the high standards of precision required for such products as the finished products are subjected to rigid testing and analysis in accordance with the Underwriters Laboratories, Inc (UL) of USA and Canadian Standard Association, which safeguard market quality standards. From 123 workers in 1992 when it started operations, the company now has 425 workers in line with the expansion of its manufacturing capabilities. The company typically sources its materials from Taiwan but also locally when available. About 90% of its products go directly to hardware stores abroad particularly in the US, Mexico and Taiwan, while the residual goes to OEMs.

4.10.1. Linkages and Innovation

The company was represented by its Production Head during the interview. He clarified that there are two companies in the Philippines under the Exito banner. One is Exito Philippines that handles indoor cords, while the other is Tai-Fini Copper and Conductors which take care of the outdoor cords and provide the copper requirements. While formal R&D is being conducted in Taiwan, the Philippine plant has engineering capability and can make samples of products. By virtue of the set-up of this company alone, it can be inferred that innovation is considered important.

[8] In the written profile of the company given to the interviewer during the dialogue, it was indicated that the firm has both Filipino and Taiwanese incorporators. However, during the interview, the Production Head mentioned that the company is wholly Taiwanese. The latter was adopted in this paper.

As a representative example of upgrading efforts, the Production Head shared their experience in upgrading the handling of their production. The process used to be segregated by stations and takes four hours to complete production. With the innovation introduced being the conveyor type process, production time was reduced to one hour. As this has helped improve the production flow, this type of upgrading is considered as adoption of new production method. It is incremental innovation as the present way of doing things was improved and considered new to the firm. As explained by the Production Head, product innovation is handled by the R&D facility in Taiwan, while the Production Department in the Philippines which houses its engineering capabilities does production improvements like the type described above. Whenever new products are developed, representatives from the Taiwan R&D unit visit to introduce the product. Since the firm started, five additional products were introduced. The Production Head emphasized that it is also convenient for the Taiwanese facility to conduct the R&D since they have an existing relationship with UL already.

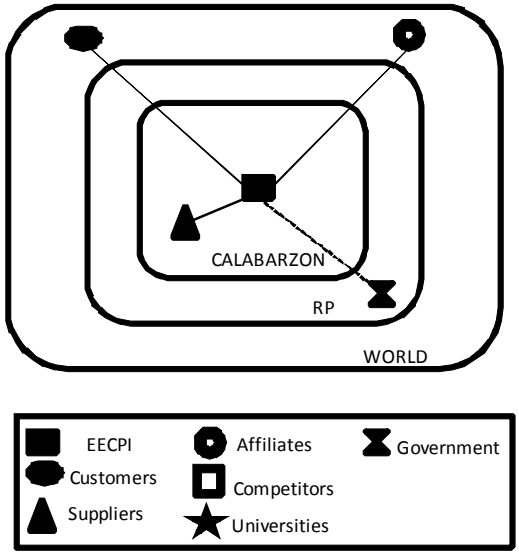

Figure 10 Exito Electronics Company Philippines, Inc. Linkages

Upgrading efforts in this company are motivated by the desire to increase market share, improve cycle time, decrease production lead time, and reduce production cost. For the particular affiliate in the Philippines, the firm's strategy for innovation is through intramural efforts by its Production Department. As for its partner in innovative pursuits, the Production Head considered its local supplier as one, which is located also in Cavite. As they also do packaging of their products, the supplier is able to provide them with state-of-the-art packaging technology while the design comes from their customers. He candidly admitted that the company does not have university linkages or membership in industry associations. As for extent of engagement with public agencies, he mentioned that they attend training programs offered by the Department of Trade and Industry (DTI) on productivity enhancements. In terms of obstacles to innovation, the Production Head indicated that their firm's capability is enough to innovate which explains why he could not cite any other partners for upgrading except particular suppliers of packaging materials.

Most of the company representatives interviewed shared their thoughts and opinions on the state of the electronics industry in the Philippines. Some relate to the need for R&D capabilities in the country, while others to the role of government in developing the industry. Their insights will be cited in the concluding chapter.

5. ANALYSIS

5.1. Summary of Survey Results[9]

A survey of firms in CALABARZON completed at the end of 2009 was intended to

[9] The survey was commissioned to the National Statistics Office (NSO) by the Philippine Institute for Development Studies and the Bangkok Research Institute/JETRO under the supporting study to the ERIA overall project on Asian Comprehensive Development Plan. This case study is intended to supplement the econometric analyses that will be undertaken by the Japanese team under said project.

generate information on production and science and technology linkages and their impacts on technological upgrading and innovation in the last three years (from 2007). The same sample of firms that participated in the 2008 survey conducted in relation to a firm-level study under the auspices of ERIA was revisited to be part of the latest survey. Selected results from this survey are presented in this section to provide a backdrop of the general situation in the region, zeroing in on electronics firms covered by the survey, before venturing into an analysis of the information gathered from the interviews of the 10 firms.

Table 7 Profile of Surveyed Firms

	Levels	% Share
Number of Surveyed Firms	203	100.00
By Sector		
Food, beverages, tobacco	34	16.75
Textiles	2	0.99
Apparel, leather	22	10.84
Wood, wood products	11	5.42
Paper, paper products, printing	5	2.46
Chemicals, chemical products	11	5.42
Plastic, rubber products	15	7.39
Other non-metallic mineral products	8	3.94
Iron, steel	13	6.40
Non-ferrous metals	1	0.49
Metal products	15	7.39
Machinery, equipment, tools	5	2.46
Computers and computer parts	7	3.45
Other electronics and components	22	10.84
Precision instruments	2	0.99
Automobile, auto parts	14	6.90
Other transportation equipment and parts	2	0.99
Other, specify:	10	4.93
NR	4	1.97
Electronics:	31	15.27
Computers and computer parts	7	3.45
Other electronics and components	22	10.84
Precision instruments	2	0.99

A total of 203 firms participated in the survey, of which, the top three manufacturing sectors in terms of number are food, beverages and tobacco; apparel and leather; and, other electronics and components. These sectors represent the

agglomerated industries in CALABARZON. When lumped together, the total number of electronics firms covered a total of 31 comprised of the following: computers and computer parts, other electronics and components, and precision instruments. As expected, the sector on other electronics and components which include semiconductors is represented the most (Table 7).

In terms of ownership of the firms surveyed, almost half are wholly Filipino-owned, a little more than 25% is wholly foreign, while the residual is rounded up by joint ventures. It should be noted that the region is dotted with numerous industrial and economic zones, preferred location of exporting and foreign firms due to the incentives offered, the facilities and the simplified process of exportation and importation. It is thus, no wonder that one half of the total samples surveyed are foreign-owned and joint ventures (Table 8).

Table 8 Ownership

By Capital Structure		
100% Filipino-owned	101	49.75
100% Foreign-owned	54	26.60
Joint Venture	48	23.65

Except for electronics and automobile and auto parts, all of the firms surveyed consider NCR and CALABARZON as their most important sources of inputs. Electronics look to Japan as its main source of supplies, followed by a wide margin by Korea and CALABARZON. This implies that Philippine electronics firms continue to be part of the production web of Japanese firms, while they have connections with Korea, China and Taiwan (Table 9).

Table 9 Most Important Source/Origin of Inputs

	Philippines (NCR)	Philippines (CALABARZON)	Philippines (Other Regions)	China (Mainland & HK)	Japan	S. Korea	Taiwan	US	Total
Food, beverages, tobacco	13	15	4					1	34
Textiles/Apparel	4	3	1	4	1	3	2	6	24
Wood/Paper	5	4	2	1	2	0	1	1	16
Chemicals, chemical products	2	1	1		2	2	1		11
Plastic, rubber products	4	6	2		3				15
Iron, steel, non-metallic products	10	6	3	1	0	0	0	1	22
Metal products	3	6		1	1				15
Machinery, equipment, tools	1			1	2				5
Electronics	**1**	**4**	**0**	**3**	**15**	**4**	**2**	**1**	**31**
Automobile, auto parts		1			12				14
Other transportation equipment and parts					2				2
Others/NR	2	3	1	2	0	0	0	3	14
Grand Total	45	49	14	13	40	9	6	13	203

In terms of affiliated firms in other countries which could indicate the industry's participation in the regional or global production network, survey results show that among all the sectors, it is the firms in the electronics industry that have the most number of affiliates outside of the Philippines. The table below shows that the electronics firms are affiliated with Singapore-, Malaysia-, China-, Japan-, US-, Europe-, Taiwan-, and South Korea-based firms. The linkage is found to be highest in Japan, China and the US. Meanwhile, the number of firms with affiliates within CALABARZON is likewise high compared to the others, denoting the agglomeration of electronics firms in the region more than in any other regions in the country (Table 10).

When it comes to the location of the most important customers, nearly half of the total electronics firms indicated CALABARZON. This indicates that their partners are proximate to their own location denoting its importance for critical production linkages and transactions (Table 11).

Table 10 Do you have affiliates in the ff countries?

	Philippines (NCR)	Philippines (CALABARZON)	Philippines (Other Regions)	Singapore	Malaysia	China (Mainland & HK)	Japan	US	Europe	Taiwan	S. Korea
Food, beverages, tobacco	6	10	10	1	2	4	2	2	2	1	0
Textiles/Apparel	1	1	3	0	0	3	2	4	2	2	4
Wood/Paper	3	5	3	0	1	0	2	0	1	1	0
Chemicals, chemical products	2	1	3	2	2	1	1	2	3	2	2
Plastic, rubber products	5	8	5	1	1	2	2	1	1	2	0
Iron, steel, non-metallic products	6	7	3	1	1	1	2	2	1	0	0
Metal products	1	2	1	4	2	3	5	3	2	2	2
Machinery, equipment, tools	2	1	1	1	0	0	3	1	2	0	1
Electronics	**2**	**12**	**3**	**11**	**8**	**17**	**18**	**12**	**11**	**5**	**6**
Automobile, auto parts	3	6	3	1	2	2	8	5	4	2	0
Other transportation equipment and parts	0	1	0	0	0	0	2	0	0	0	0
Others/NR	3	1	2	3	3	4	2	5	4	3	2
Grand Total	34	55	37	25	22	37	49	37	33	20	17

Table 11 Location of Most Important Customer

	Philippines (NCR)	Philippines (CALABARZON)	Japan	US	Philippines (Other Regions)	Grand Total
Food, beverages, tobacco	15	12	1	1	3	34
Textiles/Apparel	4	3	1	12	1	24
Wood/Paper	5	5	3	0	2	16
Chemicals, chemical products	9			1		11
Plastic, rubber products	5	6	3		1	15
Iron, steel, non-metallic products	16	4	0	1	0	22
Metal products	4	6	3	1		15
Machinery, equipment, tools	2	1	2			5
Electronics	**1**	**12**	**8**	**2**	**0**	**31**
Automobile, auto parts	3	4	6			14
Other transportation equipment and parts	1		1			2
Others/NR	3	1	1	6	1	14
Grand Total	68	54	29	24	8	203

Activities for upgrading and innovation done in the last three years were also asked and where survey results indicate that in the aggregate (all sectors), significant improvement of an existing product or service was the most common followed by the development of a totally new product based on existing technology. The same pattern was found for electronics firms alone though the latter was tied with the development of a totally new product based on new technologies. In both cases, the new products developed were mainly shopped to existing customers. When it comes to process upgrading, improvement of existing machines, equipment and facilities for both aggreggate sectors and electronics only came up as the most common mechanism. This was followed by buying new machines or facilities with new functions in the case of electronics firms. As for substantial organizational changes undertaken, the top three among all sectors are production control and management; quality control; and cost control and management. For electronics firms, the main mechanisms are adoption of international standards, enviornmental management, human resource management, quality control, and production control and management.

The top major sources of knowledge and new technologies among the surveyed firms in all the industries covered, those considered to be important, are the following:

internal sources of information and own R&D efforts; recruitment of mid-ranking personnel; participation in conferences and trade fairs; and, foreign-made equipment and software. Firms that are more internally driven have their sources in the same area where they are located or to their affiliates in other ASEAN countries; to those located in other regions in the country; and to their affiliates in Europe or the US. Presumably, these sources are their headquarters, R&D units or departments of the company or other internal departments. It is interesting that recruitment of mid-ranking personnel ranked so high relative to the others which point to the importance of getting highly-skilled and educated people on board to handle technical and management matters. The fact that these personnel are sourced mainly within CALABARZON validates previous findings that industrial agglomerations are able to gather pool of specialists, which attracts more firms wanting to tap this pool to locate in the same area. This finding also points to the possible homogeneity of production pursuits in such an agglomeration, thus enabling the mobility of labor. That foreign made equipment and software figured high in this survey is no surprise as technologies are embedded in machines and other inputs. The fact that they are foreign-made implies that these are state-of-the-art hardware. Findings by the ADB show that new machinery and equipment is the most important source of technological innovation among Asian firms, followed by internal sources and those arising from cooperation with client firms (ADB, 2009).

Participation in conferences, trade fairs and exhibit remain to be an important source of knowledge since it is expected that knowledge do get around in a gathering of industry players and technical resource persons, if any. As the government typically organizers and sponsors such events, this finding validates the need for them to continue conducting these activities or to facilitate participation of industry players in these fora, particularly to those held abroad which lends the possibility for good and wider exposure for them.

Table 12 Major Source of Knowledge and New Technologies: ALL INDUSTRIES

	No. of Respondents	Not important source	Important source	Locations of Partners/Sources					
				In CALABARZON	Other regions in the Philippines	In Other ASEAN	In East Asia	In Europe or US	In other countries
Q12.1. Internal sources of information and own R&D efforts	**203**	**91**	**112**	**47**	**25**	**29**	**5**	**19**	**13**
Q12.2. Cooperation with (technology transfer from) local firms (100% Filipino capital)	203	134	69	34	29	8	1	3	6
Q12.3. Cooperation with (technology transfer from) MNCs (100% non-Filipino capital)	203	132	71	14	10	23	6	13	17
Q12.4. Cooperation with (technology transfer from) from Joint Ventures (JVs)	203	151	52	12	5	18	5	5	9
Q12.5. Technical assistance financed/provided by support organizations such as seminar, lecture, training, technical advice, or consultant /expert dispatched or hired by them									
a. Technical assistance financed/provided by government/public agency	203	131	72	44	27	3	2	0	1
b. Technical assistance financed/provided by industrial/trade organizations	203	131	72	29	27	11	3	2	5
c. Technical assistance financed/provided by community organizations (NGOs or NPOs)	203	166	37	26	11	0	1	0	0
d. Technical assistance financed/provided by government owned financial institutions	203	163	40	25	14	0	0	0	0
Q12.6. Linkages with Universities and R&D Institutes									
a. Cooperation with (assistance from) universities/higher educational institutions	203	153	50	39	16	1	0	1	0
b. Cooperation with (assistance from) government or public research institutes	203	151	52	29	24	1	0	0	0
c. University professors or researchers individually contracted by this establishment	203	166	37	23	15	0	0	0	0
d. Dispatch your engineers to universities/higher educational institutions	203	163	40	19	21	1	0	0	0
e. Dispatch your engineers to government or public institutions	203	160	43	21	24	1	0	0	0
Q12.7. Human Resources									
a. Recruitment of middle-ranking personnel or mid-career engineers	**203**	**92**	**111**	**87**	**42**	**2**	**0**	**0**	**2**
b. Recruitment of senior engineers retired from MNCs, JVs or large firms	203	148	55	42	20	2	0	1	1
c. Headhunt of top management from MNCs, JVs or large firms	203	158	45	25	18	5	1	2	2
Q12.8. Other sources of new technologies and information									
a. Technical information obtainable from academic publication	203	134	69	35	30	11	1	7	5
b. Technical information obtainable from patents	203	149	54	20	16	14	1	5	6
c. Introduction of 'foreign-made' equipments and software	**203**	**103**	**100**	**18**	**20**	**36**	**10**	**23**	**18**
d. Reverse engineering	203	164	39	17	11	9	0	4	3
e. Participation in conferences, trade fairs, exhibitions	**203**	**83**	**120**	**51**	**56**	**28**	**6**	**11**	**13**
f. Licensing technologies from other firms	203	153	50	23	18	10	0	2	10

Zeroing in on firms in the electronics industry, it is noted that they mirror the pattern of the aggregated firms from other industries. However, cooperation with MNCs is slightly higher than internal strategies which denote that this sector is oriented

more outside of the country and is entrenched in the regional/global production networks. These firms depend more on MNCs in other ASEAN countries than in any other locations. This is also where foreign equipment embedded with technology is mainly sourced.

Table 13 Major Source of Knowledge and New Technologies: ELECTRONICS

	No. of Respondents	Not important source	Important source	Locations of Partners/Sources					
				In CALABARZON	Other regions in the Philippines	In Other ASEAN	In East Asia	In Europe or US	In other countries
Q12.1. Internal sources of information and own R&D efforts	31	16	15	5	0	6	1	4	3
Q12.2. Cooperation with (technology transfer from) local firms (100% Filipino capital)	31	22	9	6	1	2	0	0	1
Q12.3. Cooperation with (technology transfer from) MNCs (100% non-Filipino capital)	**31**	**13**	**18**	**4**	**1**	**6**	**3**	**3**	**3**
Q12.4. Cooperation with (technology transfer from) from Joint Ventures (JVs)	31	17	14	3	0	7	2	2	1
Q12.5. Technical assistance financed/provided by support organizations such as seminar, lecture, training, technical advice, or consultant /expert dispatched or hired by them									
a. Technical assistance financed/provided by government/public agency	31	18	13	9	2	1	0	0	1
b. Technical assistance financed/provided by industrial/trade organizations	31	16	15	5	4	4	0	0	2
c. Technical assistance financed/provided by community organizations (NGOs or NPOs)	31	22	9	8	2	0	0	0	0
d. Technical assistance financed/provided by government owned financial institutions	31	21	10	9	1	0	0	0	0
Q12.6. Linkages with Universities and R&D Institutes									
a. Cooperation with (assistance from) universities/higher educational institutions	31	20	11	8	3	1	0	1	0
b. Cooperation with (assistance from) government or public research institutes	31	23	8	4	3	1	0	0	0
c. University professors or researchers individually contracted by this establishment	31	25	6	4	2	0	0	0	0
d. Dispatch your engineers to universities/higher educational institutions	31	23	8	5	3	0	0	0	0
e. Dispatch your engineers to government or public institutions	31	24	7	4	3	0	0	0	0
Q12.7. Human Resources									
a. Recruitment of middle-ranking personnel or mid-career engineers	**31**	**6**	**25**	**21**	**9**	**0**	**0**	**0**	**0**
b. Recruitment of senior engineers retired from MNCs, JVs or large firms	31	15	16	15	4	0	0	0	0
c. Headhunt of top management from MNCs, JVs or large firms	31	16	15	11	5	2	0	0	0
Q12.8. Other sources of new technologies and information									
a. Technical information obtainable from academic publication	31	16	15	8	5	3	0	1	1
b. Technical information obtainable from patents	31	19	12	4	3	6	0	0	0
c. Introduction of 'foreign-made' equipments and software	**31**	**8**	**23**	**4**	**2**	**12**	**3**	**2**	**3**
d. Reverse engineering	31	18	13	4	2	5	0	1	1
e. Participation in conferences, trade fairs, exhibitions	**31**	**11**	**20**	**11**	**7**	**5**	**1**	**1**	**0**
f. Licensing technologies from other firms	31	17	14	6	3	6	0	1	0

5.2. Summary of Interview Results

Most of the 10 firms regard firm-level upgrading/innovation as important. Each of the firms explained their position in detail and in the context of their firm's history and recent developments. However, one firm, which is engaged in plastic molding for electronics products do not regard innovation as that important in the context of their company's limited production line and activities, citing their dependence on the customer for specifications and mold designs. Still evidences were found that, albeit informally, the personnel of this particular firm develop some degree of innovation in relation to mold designing on their own.

Table 14 Importance of Upgrading/Innovation

	Yes	No	Total
Local	4	-	4
MNC/FO	4	-	4
JV	1	1	2
Total	9	1	10

The upgrading activities by the case study firms are mostly related to adoption of new production method (46%), followed by introduction of new products (33%). Almost all of these innovations are incremental in nature and half are new to the firm.

Table 15 Type of Upgrading/Innovation

	Local	MNC/FO	JV	Total
Introduction of new product/service	1	2	2	5
Adoption of new production method	3	3	1	7
Creation of a new market	-	-	-	-
Secure new supplier/materials	-	1	-	1
Substantial organizational change	-	2	-	2

Firms A and B considered their work as radical innovations. Firm A, a locally owned firm that considers itself global is predominantly into high level assembly

manufacturing but offers turn-key and customized manufacturing as well. Looking at its history, it will be noted that the firm has evolved from assembly to sub-assembly to production of end-products though still not its own. Still, Firm A has already evolved from simple manufacturing to doing radical innovation which tells something about the internal capabilities that now exists in the company. The company is also into original design manufacturing that started with its establishment of an R&D facility in Manila and mainly through its acquisition of companies outside of the country – the US, Japan and Singapore -- with design and development capabilities. Firm A's strategy is reminiscent of MNCs in the sense that it has fragmented operations with locations chosen based on functional niches. For instance, manufacturing is done in the Philippines and China, design in Singapore, the US and Japan, and sales in all of these countries plus in Europe.

Meanwhile, Firm B is foreign-owned whose President described the upgrading that they have done as disruptive technology – cutting edge technology that seems to be a step up from radical innovation. Aptly new to the world and new to the market, this firm has reached the point where it is able to push the envelope, so to speak, in product development. The fact that it considers an external partner, i.e. vendor that gives inputs, in upgrading efforts in tandem with its internal capabilities highlights the importance placed by firms to their networks for fostering innovation.

Another firm that is into product development is RBWI. Similar with Firm A, RBWI has design capabilities abroad when it acquired the R&D unit of its former mother company, Remec. It has also opened its design center in Canada in addition to the one in the US, which according to RBWI's President enables the company to be close to its market. Though its presence in the Philippines is largely for manufacturing, aside from being its headquarters, the President has plans to establish an R&D facility in the country as well as earlier mentioned.

Table 16 Degree of upgrading/innovation

	Local	MNC/FO	JV	Total
Incremental innovation	3	3	1	7
Radical innovation	1	1		2

Table 17 Direction of innovation

	Local	MNC/FO	JV	Total
New to the world	1	1	1	3
New to the market	1	2		3
New to the firm	3	2		6

In terms of motivations for upgrading, the top 3 are: reduction of production cost, improvement of product quality and for compliance or fulfillment of regulations and standards. The factors that induced locally-owned firms in the case study to conduct upgrading were diverse, but the improvement of production flexibility got the more responses. Most of them indicated that their edge over competitors, especially those from China, is the quality of their final outputs and the speed that they are able to crunch them out. It is also important that the reject rate is very low to generate cost efficiency on the part of their customers. According to them, this capacity is what sets them apart with their competitors in other countries. For MNCs, their rationale is much more diverse than their local counterparts and considered all of the options presented as applicable to them, except the option on enhancing non–price competitiveness. Meanwhile, only one joint venture firm provided a response to this question since it is the only one among the two joint ventures that actually undertakes upgrading.

Table 18 Motivations of the Upgrading/Innovation Effort

	Local	MNC/FO	JV
Replace products being phased out	-	2	-
Improved product quality	1	3	-
Extend the product range	-	1	-
Open up new markets	-	3	-
Increase market share	1	1	-
Fulfill regulations & standards	1	3	-
Improve cycle time	1	2	-
Decrease R&D lead time	-	1	-
Decrease production lead time	-	2	-
Decrease delivery lead time	-	2	-
Improve production flexibility	2	1	-
Reduce production cost/ materials energy	1	3	1
Reduce environment effects	-	2	-
Improve work conditions for employees	-	2	-
Learn about new technology	1	2	-
Enhance price competitiveness	1	2	-
Enhance non-price competitiveness	1	-	-
Others	1	-	-

As for the firms' internal strategies to foster innovative activities: intramural or in-house R&D and engineering garnered the top spot, followed closely by training related to innovation activity and then acquisition of machinery and equipment in connection with product or process innovation. For locally-owned firms, internal capabilities to undertake upgrading is evident, while the others get the technological information embedded in machinery and equipment acquired. Training their manpower is also considered a strategy for upgrading efforts. Among the MNCs, training is their go-to strategy to enable them to do innovation, followed by their internal capacities.

Also captured during the interview was the high-regard some of the interviewed firms give to their manpower, in general, and the operators, in particular. Many of these firms have mechanisms in place to capture ideas for upgrading that their employees might have. One of the firms even mentioned that to get good ideas about improving production processes, go to the floor and ask the operators who are in the thick of the action, so to speak. This does not imply though that it is no longer necessary to have a formal R&D or product/process development unit since ideas would have to be

translated to operational or implementable activities to be able to be really useful. Still, this goes to show that a management that is open to ideas percolating on the floor or in any of the business units is able to accumulate useful information for upgrading and innovation and such information need not always be high technology-based especially in relation to improvements in production processes.

Table 19 Ownership

	Local	MNC/FO	JV	Total
Intramural/In-house R&D/engineering	2	2	1	5
Acquisition of R&D (extramural/external R&D)				0
Acquisition of machinery and equipment in connection with product or process innovation	1	1		2
Acquisition of other external knowledge such as licenses to use intellectual property or specialized services		1		1
Training related to innovation activity	1	3		4
Reverse engineering		1		1
Basic design to change main features of products		1		1
Detailed design after the main features of products have been set				0
Market introduction of innovations		1		1
Others	1	1		2

Given that the firms relied more on their internal capabilities for the upgrading efforts, the specific contributors to these were their in-house R&D department, among those who have, and to those that do not have formal R&D units, other internal departments.

Table 20 Contributors to Upgrading/Innovation

	Local	MNC/FO	JV	Total
External Partners	2	1	-	3
In-house R&D department	2	2	1	5
Other internal departments	3	4	-	7
Own affiliates	1	-	-	1

Meanwhile, the top 3 partners for innovation are customers, foreign-owned suppliers and local-owned suppliers. This highlights the notion that production linkages are the main pathways toward upgrading in the cases of these firms. As with the

previous study, linkages with knowledge stakeholders like universities and research institutions were found to be less of a driver in fostering innovation. Most of the partners for upgrading and innovation are located within the same industrial area (CALABARZON) and for many, even in the same economic zone. This finding denotes that knowledge do circulate in an agglomeration setting, particularly when involving an industry where the lead firm-follower firm theory is found in practice. Though technology now enables virtual collaboration among participants located in various parts of the world, “face to face” interaction, though more institutional in arrangement than personal, enables more regular interface perhaps due to proximity and convenience to get together. Of course, it should also be considered that quite a number of electronics firms are dependent on the customers for design and specifications in relation to assembly work, which make them important partners for upgrading. Thus, if the customer would have limited product range, then it follows that the firm would also have limited chances for diversification and product innovation. However, this does not preclude the possibility that the firm itself can undertake other types of innovation, not least of which is process innovation to strengthen its competitive edge among other providers of low-cost manufacturing. This has been observed in the cases of some of the firms in this current study. Meanwhile, there are also partners that are located across agglomerations, which are in other regions of the country or in another country (Table 21)

The typical mode of collaboration between the firms and their partners is informal information exchange and technology assistance. The exchange of technical personnel is also being done. Some of the information exchanges occur during personal interactions, as in the case of one firm whose engineers already established personal rapport with their counterparts through regular meetings. In fact, the electronics firms in the case study do dispatch engineers to their partners and vice versa (Table 22).

Table 21 Partners for the Upgrading/Innovation

	Local	MNC/FO	JV	Total
Locally-owned suppliers	1	2	1	4
Foreign-owned suppliers	-	3	1	4
Firms in the same business group (parent companies/affiliated companies/other subsidiaries	1	1		2
Customers	3	3	1	7
Competitors	-	1	-	1
Firms in other industries	1		-	1
Universities or other higher education institutes	-	1	-	1
Public research institutes	-	-	-	0
Financial institutions	-	-	-	0
Consultants who belong to universities or other higher education institutes as faculty or researcher	-	1	-	1
Other independent consultants or consulting firms	-	-	-	0
Other business service providers (private R&D institutes, market research company, etc)	-	-	-	0
Community organizations (NGOs/NPOs)	-	-	-	0
Others	-	-	-	0

Table 22 Collaboration Mode

	Local	MNC/FO	JV	Total
Informal information exchange	2	2	-	4
Joint R&D projects	-	1	1	2
Contract research	-	1	-	1
Licensing technology	-	-	-	0
Technology assistance	2	1	1	4
Human resource development	1	-	-	1
Exchange of technical personnel	1	2	-	3
Financing innovations	-	-	-	0
Others	-	-	-	0

Internal obstacles for innovation are quite spread out among the choices given but these two garnered the top responses: perceived costs too high and limited financial resources. On the other hand, external barriers include inadequate support services and lack of customers' interest in innovation. It is worth noting that although many of the firms considered this particular question on innovation as obstacles, it was observed that such challenges could not have seriously impaired the capabilities of the firms to upgrade in various ways and degrees. Based on the firms' responses, policy supports or public programs were rarely tapped, if any, in their upgrading or collaboration efforts. This could be because firms tend to rely on their own, internal capabilities and to

partner with their customers and suppliers/vendors. This implies that perhaps, there are other roles for government that they could perform more substantially to matter to these firms.

One firm highlighted the fact that collaboration could indeed mitigate particular obstacles through mutual testing and sharing of liability. Still, there are perceived obstacles to collaboration with the top 3 responses as follows: difference in time horizon (both literally and in terms of strategic thinking); intellectual property issues; and the perception that the firm's capability is enough to enable it to innovate. Based on his experience, one CEO mentioned that differences in viewing time horizon is costly as well. He was asked by a major customer to put up a facility with a promise that it will be utilized once he has fulfilled all its specifications and requirements. Although he has already invested substantially to the facility, the tactical delays on the part of the customer frustrated him and delayed as well the returns on his investment. The CEO is now looking at the short term horizon to be able to recoup his investments but apparently the customer has a longer time frame. Hence, if partners do not agree on a common time frame and do not commit on it, the collaboration would not push through.

Table 23 Obstacles of Upgrading/Innovation: Internal Factors

	Local	MNC/FO	JV	Total
Perceived risks too high	1	1	-	2
Perceived costs too high	1	2	-	3
Limited financial resources	3	-	-	3
Internal resistance to innovate	-	-	-	0
Lack of information on technology	2	-	-	2
Lack of information on markets	1	-	-	1
Others	1	1	-	2
Obstacles of Upgrading/Innovation: External Factors				
	Local	MNC/FO	JV	Total
Lack of qualified personnel	1	-	-	1
Inadequate support services	2	-	-	2
Lack of government support	1	-	-	1
Lack of customer interests in innovation	1	1	-	2
Lack of competition in the market	-	-	-	0
Others	1	-	-	1

6. CONCLUSION AND RECOMMENDATIONS

The case study began with a more macro view on upgrading. Since the Philippine electronics industry is concentrated on the low value added segment of the value chain, any upgrading is thought to lead to the higher segment that is, design and own brand, own product manufacturing. When the case study went into the micro, a slightly different perspective emerged. That while the Philippine electronics industry is mainly concentrated in the assembly and test segment of the value chain in the past three decades, this does not mean that innovation has been stagnant. Indeed, even in the lowest segment of the value chain, upgrading is possible and being undertaken. With both of the macro and micro perspectives in mind, a summary of insights derived from the case study is enumerated, together with some policy suggestions at the national and regional (ASEAN+6 level).

1. Firms in CALABARZON do indeed innovate. This has been proven based on the three firm-level surveys already undertaken in this area since 2007 across various industries and firm characteristics.[10] The survey results are consistent that these activities tend to be limited to the first stage of innovation, that is, development of new product based on existing technologies for existing markets. Process innovation meanwhile is primarily through equipment and facilities improvement to increase productivity and to respond to customer specifications. It is quite possible that manufacturing in the Philippines, in general and in CALABARZON, in particular is limited to the lower stage of innovation because of the types of activities involved. For instance, the electronics industry in CALABARZON is mainly engaged in

[10] The first survey included manufacturing firms in Metro Manila as the geographical locus of the study then was Greater Manila Area composed of Metro Manila, Cavite and Laguna.

manufacturing and specifically, in assembly and testing. This already denotes a dependence on the customer and the jobs assigned by MNC affiliates or mother companies.

This is also evident in the types of technology assistance some electronics firms ask from knowledge stakeholders like ERDT for instance, i.e. on manufacturability and failure analysis. Dean Guevarra of the ERDT was of the view that manufacturing companies in CALABARZON should not be expected to do R&D since these firms are mainly recipients of R&D outputs from elsewhere. She added that R&D activities happen mostly in Metro Manila where the infrastructure and facilities are relatively stable and where the top universities with more advanced amenities are located. It is also in Metro Manila where government research institutions and private knowledge providers are located. Though these considerations are important given that high value knowledge spillovers may indeed occur where the knowledge stakeholders are, the fact that CALABARZON is the manufacturing center of the country should not deter it from undertaking R&D or mechanisms for upgrading and innovation where it is at. Universities have already established branches in the region and there are regional government offices as well. The issue here is how to encourage closer interaction and collaboration among actors in this agglomeration for knowledge flows to happen and be utilized for innovative purposes.

On the other hand, there are firms that take a different route in terms of the conduct of R&D activities. Firm A and RBWI acquired R&D companies or at least have R&D facilities in other countries where their manufacturing operations become recipient of their outputs. Aside from product introduction, these manufacturing firms which also have internal engineering units have capability to make use of these R&D outputs and adapt them to customer specifications or local conditions. Thus, it is important to also have the absorptive capacity for technology available in the recipient firms or branches,

regardless of where the technology came from.

2. In the past 30 years, the electronics industry in the Philippines has hardly moved up the high value segment of the supply chain. Aside from the above cited reasons it is also opined that the industry might have rested on its laurels or has adapted a mindset that it is "too successful to fail." The reason given was that, even in the face of tough competition, investments continue to come in and the industry remains to be the top export earner for the country. Another compelling reason is the fact that the industry is also a top employment generator in the country, the bulk of which is in the lower skills level. Should electronics firms shift to design and other advanced operations and start limiting their production in favor of the former, then employment would suffer. In fact, this is one of the motivations of EMS-CAI for its establishment, that is, to provide employment to Filipinos.

However, if the building up of skills could happen with the industry, the firms and its people together, then the latter could still be employed and possibly, with an even higher pay scale should the companies be successful in their new ventures. Admittedly, this process would take time and has to start somewhere.

3. Increasingly, there is recognition that the electronics industry has to start transforming and move up the value chain. All the players, whatever the time frame, have the view that this should happen in order to buttress the competition. The SEIPI, which boasts of a membership bordering to about 200 comprised of the MNCs and medium to large local firms, is of the view that despite 30 years in the electronics industry, the Philippines may not yet be ready to take on the high value segment of the production chain as the critical factors are not yet adequately in place. For one, technological capabilities are not yet on a level to take on the high tech challenge, which

is the reason why the association is venturing into programs like helping improve the curricula of engineering programs and providing scholarships to generate Masters and PhD graduates. On the other hand, the Electronics Industry Association of the Philippines, Inc. (EIAPI) which brings together small local companies venturing into IC design, embedded systems and other high technology ventures in the industry is already pushing for government and private sector support for venturing into design and other frontiers in the electronics industry.

There is legislation pending for the establishment of an institution akin to the Industrial Technology and Research Institute of Taiwan, which will focus on conducting research and generating technology on an industry one at a time, starting with electronics, if possible. This effort has garnered a critical mass of support with COMSTE, ARCDI, EIAPI, and the DOST pushing for its realization. As Dr. Tangonan (2008) pointed out, this industry-led institution would conduct applied R&D, prototype development and commercialization of high value added electronic products. It will also help focus S&T investments of government, industry and academe to achieving specific milestones. ITRI-Philippines would grow new business in chip design, green engineering and biomedical electronics and would represent the electronics industry in capturing new investments for the electronics sector. In effect, this industry-led but government-supported endeavor would be the intermediary between the stakeholders and players in the electronics sector. Eventually, this Institute could establish a branch in CALABARZON akin to the Penang Skills Development Corporation that is dedicated to catering to the needs of the firms in the Penang cluster. Such an institution is sorely needed in CALABARZON that would serve to integrate all programs offered for all the industry within it and be the bridge that would pave the way for stronger linkages for innovation. These ideas are consistent with efforts on FilipINNOVATION to engender a culture of innovation among Filipino firms and the people, in general.

4. It is inspiring to note that companies that are willing to develop themselves further into world-class level are able to do that by continuously beefing up their toolkits with the appropriate technological capabilities and networks. Firm A has evolved from sub-assembly to assembly and into turnkey, customized manufacturing, without necessarily producing their very own products. Acquisition of technology was not limited to the outputs of their R&D and engineering units but also, by acquiring other firms that already have the capabilities for designing and high-technology production. Both Firm A and RBWI have done this, and both are majority owned Filipino companies, if not wholly owned. Indeed, all the firms in the case study have internal strategies and mechanisms for capturing technological information and adopting them into useful endeavors for productivity improvement and skills enhancement.

The inflection point for Firm A was the decision to adopt a "global" mind-set and had this inculcated within the organizational dynamics. This enabled them to build up a strong and credible reputation and has become a strategic partner of MNCs and local firms alike. On the other hand, RBWI is benefiting from its "technopreneur" President who followed the example of Taiwanese engineers from the US who went back to their country to successfully build up electronics firms. While a "Balik Scientist" (Returning Scientists) program is being implemented by the DOST, it would also augur well for the industry if the Department of Trade and Industry (DTI) could establish a similar program for returning or retired engineers in other countries and entice them to transfer in the country knowledge and technology acquired from their years of experience in other countries. As "technopreneurs," the government, in collaboration with industry associations, can offer incentives and financing support to those who would be interested to set up their own companies in the country.

5. This study has shown that production linkages are the main pathways to industrial upgrading and innovation among firms in the Philippine electronics industry. These business links are not limited to those within the agglomeration where they are located but extend outward, to their affiliates in other countries. In other words, being entrenched in a production network enables information exchange and fosters innovation. The appropriate direction therefore, is to continue efforts to attract investments into the country, in any of the components of the electronics industry, whether on semi-conductors still or electronics manufacturing services, whether in the low value added segment of the value chain or on the higher level. What is important is that knowledge is generated, gets shared and captured for productive and innovative purposes.

In contrast, public policies and programs purportedly targeted at the industry did not figure prominently in the study as viable sources of technological information. Linkages with universities exist but modes of collaboration are limited to employment sourcing, on-the-job-training and plant visits. Nevertheless, there are already seeds planted in terms of the potential for better modes of collaboration between firms and universities. For some firms, joint projects have been done and underway as well as facilities for mutual learning, i.e. engineering faculty and students visiting the plant and learning about production processes and personnel of firms serving as resource persons in classes are being built. According to ERDT, academe-industry linkages are evident in the donations and contributions coming from the latter such as laboratories and equipment. It was asserted that companies with well defined technologies and R&D activities find ways of connecting and linking up with universities. The experiences of Firm A and RBWI in this regard can serve as examples.

As for the role of industry associations, SEIPI already has the structures, institutions and mechanisms in place for information exchange and networking. In fact,

several networks on different business units are in place where it is hoped that exchanges on the 'best known methods' are already underway.

6. As for the national government, its emerging role seems to be the provision of the strategic vision for the electronics industry. Although there are roadmaps here and there, an integrated strategy solely focused on the industry and where it should be heading is amiss. It is in this area that the industry associations and the firms themselves agree on. Having such a framework would enable prioritization of policies, programs and allocation of resources. This industrial framework should be linked with the medium-term regional development plan for consistency and to establish a timeframe or milestones for these plans and strategies. These should of course be accompanied by funding support for programs where the industry players themselves and the association can buy in. A critical area needing such support is curriculum development as it has been pointed out many times that the engineering curriculum in the country is no longer responsive given the current milieu.

On the other hand, the local government, particularly the provincial governments encompassed by the CALABARZON configuration should start asserting themselves more strongly for the sake of local economic development. A local innovation system following the FilipINNOVATION framework should be put in place at the provincial and then in an integrative manner, at the regional level. These local governments can pool their resources and contribute in various endeavors such as the establishment of a CALABARZON Skills Development Center; common facilities for the use of the industries located within their jurisdictions which can be done in cooperation with PEZA and administrators of economic zones in the region; and the improvement of the overall business environment in the region. The latter is critical as the region's infrastructure still leaves much to be desired particularly in its internal road network,

flood and drainage system, among others. Taxes and fees should likewise be rationalized in order not to put undue burden on existing business locators and in order to attract new investments to come in. Since there are no regional governments in the Philippines, this consortium of local government leaders should take up this role in close coordination with the regional office of the NEDA and their respective local development councils with various stakeholders as members including industry players.

7. One missing link in this linkages-innovation nexus and that is the link with the local supporting industry. The content of electronics production in the country is significantly foreign, making it dependent on imported inputs. The Filipino firms covered in this case study already have systems in place, however limited, in developing local suppliers. For instance, RBWI has facilitated the upgrading of capabilities of one local supplier that is now able to supply materials for its ODU – after starting out with supplying motorcycle manufacturers! On the other hand, developing local suppliers is also limited by the type of production electronics firms are engaged in. Assembly manufacturing depends mainly on materials and inputs coming from their customers that more often than not are sourced outside of the country.

The potential diversification efforts of firms or their evolution towards turn-key manufacturing may augur well for the local supporting industry. Government has to contribute to this effort by developing capabilities of the local supplier base – tying it up with its SME development programs. In other countries, local content was a requirement asked of investors, but tied up with the incentive structures available. These are worth considering in order to bridge the missing link in the electronics supply chain. For their part, local suppliers should reset their mindset that they are supplying to companies that are well entrenched regionally and globally. This implies that they themselves would have to upgrade and be world-class firms.

8. Being entrenched in the regional production network, there are cooperative mechanisms that can be instituted that relate to and go beyond production linkages. For one, there is a need to determine the niches of each country in the region on various industries many of them are commonly engaged in. While it is more or less clear that Malaysia and Thailand are into components assembly, Indonesia into lighting electronics, and the Philippines into semiconductors, it would augur well for the electronics industry at the regional level to find out the specializations of new entrants like Vietnam, China and others. Such specifications would signal to the MNCs/lead firms that indeed, the Asian region is the best destination for electronics production with specific countries having expertise in particular segments or sub-sectors.

One of the obstacles to innovation that was identified by the case study firms was the lack of information when it comes to technology and on markets. While this should also be pursued at the national level, creating a database of currently available technology, suppliers and information on buyers' needs could be an important regional effort, not only for electronics but for other industries as well.

In terms of the upgrading of technological capabilities of researchers, scientists and engineers, a possible collaborative effort can be an exchange program that would enable them to learn various technical aspects of operations in different countries. This would expand their knowledge as well as allow them to experience the organizational dynamics in a different setting. In addition, a Washington accord-type of accreditation or equal mutual recognition of engineers, scientists and researchers would facilitate further the exchange of experts and the engagement of technology consultants.

Still in relation to the exchange of manpower, it would be instructive for local and regional government officials, planners and industry experts to visit industrial

agglomerations considered best practice models namely the Penang Cluster in Malaysia and Bangkok's automotive cluster. The PSDC is a good model to study for local government officials from CALABARZON for the possibility of establishing a similar institution in the area.

The electronics industry in the Philippines is one of its most important industries, top export earner and employment generator. Its concentration in CALABARZON was instrumental in transforming the region into an advanced industrial cluster that attracted other industries and increased the revenue base of the local governments within its jurisdiction. Top universities and other educational institutions have established branches and affiliates and have increasingly been linking with firms in the region albeit limited mostly to internships and plant tours. After 30 years of existence, time is ripe for the industry to start moving up the value chain, boosted by an innovative and entrepreneurial culture that would have to be strengthened among Filipinos. This transformation of the industry should be supported by stronger linkages with sources of technological information and the government, both national and local. This is one of the more important initiatives to ensure that the industry, CALABARZON and the country could withstand competitive pressures and be on its way to progress and development.[11]

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