SUSTAINING TOTAL QUALITY MANAGEMENT: EXAMINING IN PROCESS ANALYSIS AND LAYOUT DESIGN AT INARI TECHNOLOGY SDN BHD

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DECLARATION

I hereby declare that the project is based on my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at USM or any other institutions.

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ABSTRAK

Pelaksanakan program Pengurusan Kualiti Menyeluruh (TQM) adalah lebih daripada hanya memasang sistem dan prosedur. Ia akan melibatkan usaha, pelbagai perubahan dan komitmen yang tinggi. Tambahan lagi, tanpa mangamalkan budaya ini dengan memberikan penekanan kepada kerja berpasukan, penglibatan pekerja, penambahbaikan yang berterusan, fokus kepada pelanggan dan gaya kepimpinan yang sesuai, maka program TQM yang utuh dan kekal tidak boleh dicapai. Walaupun bagaimanapun, ianya masih boleh dan sedang dipraktikkan.

Pada masa kini, Electronics Manufacturing Services (EMS) adalah didorong oleh persaingan yang tinggi, kepuasan pelanggan dan perubahan teknologi yang pesat. Sejajar dengan peningkatan di dalam sektor pembuatan, syarikat-syarikat perlulah menyesuaikan keadaan mengikut perubahan tersebut dengan perkhidmatan yang ditawarkan. Satu metodologi mereka bentuk semula kemudahan telah dibangunkan di dalam kajian kes ini untuk Inari Technology Sdn. Bhd. Kajian kes ini mengkaji proses pembuatan cip "*Bluefin*" di bahagian pengeluaran "*Chip-on-Board*" (COB) and "*Multi-Chip-on-Board*" (MCOB). Setelah mengkaji kajian kes ini, terdapat beberapa struktur alternatif telah dibangunkan dan disimulasikan untuk memastikan dapat menghasilkan tenaga kerja yang lebih efektif dan produktif.

ABSTRACT

Implementing a Total Quality Management (TQM) program is more than simply installing systems and procedures. It will involve a lot of hard work, a lot of change and an enormous amount of commitment. Furthermore, without a supportive culture with an emphasis on teamwork, employee involvement and participation, continuous improvement, a customer focus and the appropriate leadership, there cannot be a sustainable TQM program. Despite this, it can and is being achieved.

Nowadays, Electronics Manufacturing Services (EMS) industry is driven by increased competition, sophisticated customer demands and rapid advances in technology. It is therefore necessary to define methodologies for manufacturing that are capable of identifying the driving forces of change and coping with the resultant changes. In this paper, a methodology has been developed to re-design facilities at Inari Technology Sdn. Bhd. A "Bluefin" chip manufacturing facility in Chip-on-Board (COB) and Multi-Chip-on-Board (MCOB) assembly production has been examined as a case study. After modelling the initial situation, alternative structures have been developed and simulated in order to ensure a more effective and productive workforce.

CHAPTER 1

INTRODUCTION

1.0 Background of the Case Study

The electrical and electronics (E&E) is the leading industry in the manufacturing sector in Malaysia where the semiconductor power has been available in a low price to the customer. Furthermore, the manufacturers of these devices never have more severe pressure to be competitive. Every three to six years the cost is increasing to bring a semiconductor manufacturer to the industry where product complexity is rising, fracturing market and product segmentation is increasingly, lead times and available margins are shrinking, and the historical avenues of cost improvement are all approaching the limits in devices yields, line yields and even device shrinking.

Inari Technology Sdn. Bhd. is an Electronics Manufacturer Services (EMS) provider to multinational and local electronics product manufacturers. The company is specializes in substrate base hybrid / System-in-package (SiP) packaging, Printed Circuit Board Assembly (PCBA) and Box-Build. The company established in June 2006, was known as a medium enterprise because of its annual sales turnover is between RM10 million and RM 25 million. However, in the company Financial Year Ended (FYE) 2008, the company is now classify as a big company due to its increasing annual sales turnover over this past few years. The company products are mainly used in the wireless telecommunications, including smart phones, 3G devices, cellular phones, wireless communications, computing peripherals and medical sectors.

The complexity in manufacturing processes of these products is an effort to meet the special market-driven product features demands. The main issue in reaching these demands is the delay of the product to the customer and the standard of quality is according to the requirements.

According to ISO 9001:2008, Quality Management (Praxiom Research Group Limited, 2010) can be defined as follows:

> *"Quality Management includes all the activities that companies use to direct, control, and coordinate quality. These activities include formulating a quality policy and setting quality objectives. They also include quality planning, quality control, quality assurance, and quality improvement".*

Total Quality Management (TQM) is "*a management philosophy that seeks to integrated all organizational functions such as marketing, finance, design, customer service, engineering and production to focus on meeting customer needs and organizational objectives*" (iSixSigma, 2011). According to Goal/QPC Research Committee (1990), TQM is "*a structured system for meeting and exceeding customer needs and expectations by creating organization-wide participation in the planning and implementation of breakthrough and continuous improvement processes. It integrates with the business plan of the organization and can be positively influence customer satisfaction and market share growth*". In job satisfaction and the successful of TQM programs needs knowledge and skills as part of one's job and in the working environment a positive relationship should be developed.

In the process of absorbing the TQM Concept in the Malaysian industrial activities, all sorts of terms of TQM are use among managers of industrial companies. Among the terms are the Kaizen concept, teamwork, continuous improvement, lateral thinking, creativity, participative management, leadership, innovation, sustainability and many others. Various names of leaders in Quality such as Peter Ducker, Juran, Deming, Ishikawa, Stephen Covey and many others were mentioned and quoted. The works of these authors were referred to as understanding the concept and practices of TQM.

TQM is continuous activities as long as the company strives with determination and continuity to keep on providing service to the customers. The management function is to determine the quality policy, objectives and responsibilities, and implementation of the quality systems are quality planning, quality control, quality assurance and quality improvement. Hence, TQM programs are a cultural in which emphasis on including total involvement of employees in the practices and expecting them to be responsible for the quality practices in the company.

There is no doubt that TQM is the main focus for many companies. However, there is no structure or standard for a company to follow and start TQM. For example, Shell Malaysia launched its TQM program in 1988. As a foundation to the company-wide TQM structure and to reinforce to their customers that they have established system to manage quality, the quality assurance program was used (Ariffin, 1993). A year later in 1989, they started the program which involved the certification of key business processes to ISO 9000 standard. However, TQM is more than just a quality assurance program because the quest for quality is not continuous even after the company receives its accreditation to a quality standard.

In this case, it is focusing on the sustainable TQM that examining in process and layout strategy that influence the company's effectiveness and efficiency of their performance. Several issues causing by the process and layout facilities in delivery performance such as costs, work in process inventory, productivity, lead-times, resource utilization for example such as space, operation and others. However, the manufacturing costs, materials handling and layout are partly attributed thirty to seventy five per cent of the total cost (Chiang and Kouvelis, 1996). Hence, this study is focusing on the link between quality practices, existing current process and layout that effected the product delay.

1.1 Problem Statement

In sustaining productivity, Total Quality Management (TQM) can be fulfil to its true potential by introducing, managed with care and understand the real nature of the business. At the most general, TQM is one of the tools to change the culture of a company to one where there is a common ownership of corporate goals, wide spread commitment of the work force, genuine two ways communication and give a real opportunity to develop employees to high levels of effectiveness.

Weiss and Gershon (1989) defined that redesigning facility in a factory is "*everything needed for the physical arrangement of product or service, including machines, employees, raw materials, and finished goods. The criteria for a good layout necessarily relate to people (employees and customers), materials (raw, finished, and in process), machines, and their interactions*". They also summarized that "*facility layout must be considered very carefully because we do not want to constantly redesign the facility*."

On the other hand, Krajewski and Ritzman (2005) stated that "*a process chart drills down on the job level for an individual person, a team, or a focused nested process. In concentrates in more detail on a smaller number of steps than does a flowchart. A process chart is an organized way of documenting all of the activities performed by a person, by a machine, at a workstation, with a customer, or on material*".

Therefore, this case study aims to determine and evaluate Inari Technology's current TQM practices especially in Chip-on-Board (COB) and Multiple-Chip-on-Board (MCOB) assembly operations layout designs and processes that could be improved related to people, materials, machines, and their interactions where the company main issues is the product delay. In addition, analysis is carried out not only to identify the areas of Inari Technology is lacking at or their limitations but also to determine their performance in the industry.

1.2 Research Objectives

The purpose of this research is to examine and evaluate on the current layout designs and processes of product delay in Inari Technology Sdn. Bhd. This study also looks into the issues related to product delay in Inari Technology's current layout designs and processes as such the reason they still maintain the current layout and the challenges they faced due to this layout. Hence, the research objective is to provide insight on their current layout designs and processes on product delay issues to improve their current layout designs and processes in turn to appropriate recommendations.

1.3 Research Question

Based on the scenario in the beginning of this chapter, three research questions were identified for this case study due to product delay. The research questions are:

- What is the current layout and process of Inari Technology Sdn. Bhd. being practices?
- What are the issues and problems of product delay with Inari Technology's current COB and MCOB layout design and processes?
- How to improve the current COB and MCOB layout design and processes to be more efficient to Inari Technology?

1.4 Case Issues

In this case study, several issues on product delay are identified such as:

- To identify the current layout design and processes of Inari Technology and the reason the company has the existing layout
- To identify the issues the company faced with the current layout design
- To provide recommendations and ways to improve the layout design

1.5 Significance of Study

In this case study is exploring to sustain TQM especially in Layout Strategy and Process Analysis in the company because of the product delay issues. The study is focusing on the company factory layout and application of floor diagram and process chart. The company is an Electronics Manufacturing Services (EMS) who specializes in substrate base hybrid / System-in-package (SiP) packaging, Printed Circuit Board Assembly (PCBA) and Box-Build. Therefore being one of the manufacturers, it is vital for a company to understand the importance of having a strategic and efficient factory layout to enable them to further improve their productivity. Some of the issues that could be highlight such as (Kumar, n.d):

a) "Poor utilization of available floor space
b) Delay of work proceeds from one point to another point
c) Not enough production capacity
d) High material handling cost
e) High hazards to personnel
f) Poor labour efficiently
g) Low employee morale
h) High accident rates
i) No flexibility for volume and product
j) Poor supervision and control
k) Poor employee safety and health
l) Low ease of maintenance

m) Low machine or equipment utilization

n) Low productivity"

Subsequently, in Kumar (n.d) course notes stated that "*factory layout is an important decision because it represents long-term commitment. An ideal factory layout should provide the optimum relationship among output, floor area and manufacturing process. It facilitates the production process, minimizes material handling, time and cost, and allows flexibility of operations, easy production flow, makes economic use of the building, promotes effective utilization of manpower and provides for employee's convenience safety, comfort at work, maximum exposure to natural light and ventilation. It is also important because it affects the flow of material and processes, labour efficiency, supervision and control, use of space and expansion possibilities etc*".

According to Aft (2000), often the best way to utilize a person in the manufacturing process is not to use the person at all. In other words, the best use of the human is no use of the human. People do many things well, decision making being an excellent example. There are many things that machines can do better than people, such as highly repetitive tasks. Machines are much more consistent in the performance of these tasks.

In the context of the Electronics Manufacturing Services (EMS) industry, this study will be able to signify the importance of having a strategic facilities design which then will contribute to effective material handling. Canen and Williamson (1996) said that "*facilities are of crucial importance to companies because, usually, they represent the largest and most expensive assets of the company. The layout planning of facilities constitutes an important logistics management*

issue to be faced by a company. If not tackled in the early phases it can generate logistics implications for the company involved. The main concern with the plant facility layout planning is to reduce the cost of materials handling, as poor materials handling can generate business problems". As Sims Jr. (1990) stated that in his article "*The best materials handling is no handling*". Hence, this would definitely have a major impact on the productivity and profitability of a company directly and the industry as a whole indirectly. The quality and cost of the product and, therefore, the supply or demand ratio are directly affected by facility design.

1.6 Organization of the Thesis

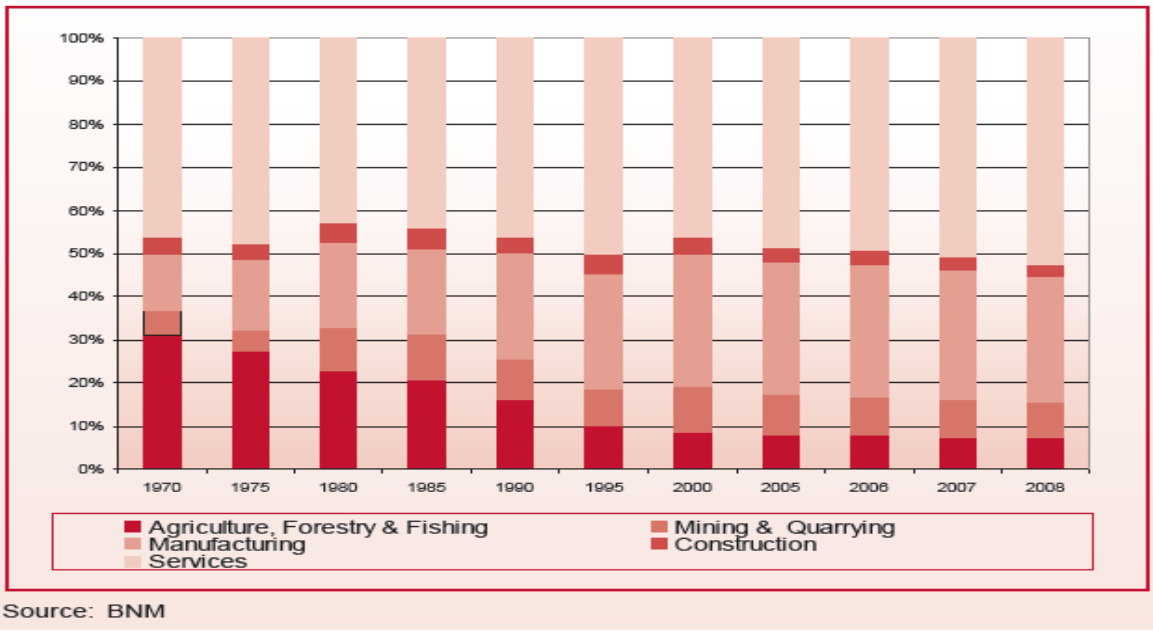
Chapter 1	:	Introduction
Chapter 2	:	Manufacturing Industry
Chapter 3	:	Literature Review
Chapter 4	:	Methodology
Chapter 5	:	Case Write-Up
Chapter 6	:	Case Analysis
Chapter 7	:	Recommendations and Conclusion

CHAPTER 2

MANUFACTURING INDUSTRY

2.0 Overview of the Malaysia Manufacturing Sector

The fastest growing sector of the economy over the past generation has been the manufacturing sector as shown in Figure 2.1. According to Bernama (2010), the manufacturing the rapid growth start in 1980s and keep on developing more than 30 per cent of output by the 2000s compared to 1970 was less than 15 per cent. The government mainly focused on the Electrical and Electronic (E&E) sector in supply, logistics and services to attract multinational firms to invest in Malaysia. Apart from this, Bernama (2010) also stated that Malaysia has become the important exporter of consumer and industrial electronic product, which ready to the next technological leap more innovatively, and higher value added, cutting-edge technology industries to be part of supply chain networks within the global requirements. The shape and structured trends of the economy are highlighted by the supply of the products and services as shown in Figure 2.2.



Source: BNM

Figure 2.1: Sector Contribution to Gross Domestic Product (GDP) (in percentage)

Source: New Economic Model for Malaysia Part 1 (National Economic Advisory Council, 2009)

Table 9 – Gross domestic product by industry origin, 2010-2020

Sectors	RM million (in 2000 prices)			% of GDP			Average annual growth rate (%)	
	2010*	2015	2020	2010	2015	2020	2011-15	2016-20
Agriculture, forestry & fishing	40,172	46,706	53,153	7.5	6.4	5.2	3.1	2.6
Mining and quarrying	41,867	44,309	46,615	7.8	6.1	4.6	1.1	1.0
Manufacturing	138,852	181,465	245,140	25.8	24.9	24.2	5.5	6.2
Construction	16,963	20,559	24,019	3.2	2.8	2.4	3.9	3.2
Services	317,010	453,831	682,401	58.9	62.4	67.3	7.4	8.5
GDP at 2000 constant prices	538,069	727,510	682,401	100.0	100.0	100.0	6.1	6.9

Sources: MOF, BNM & EPU

* Based on EPU estimates

Figure 2.2: Gross Domestic Product (GDP) by Industry Origin, 2010-2020

Source: New Economic Model for Malaysia Part 1 (National Economic Advisory Council, 2009)

Based on National Economic Advisory Council (2009), "*the New Economic Model (NEM) could be achieved through the Economic Transformation Programme (ETP) that constitutes a key pillar, which will propel Malaysia to being an advanced nation with inclusiveness and sustainability in line to achieve the goals in the Vision 2020. The core ETP will be driven by eight Strategic Reforms Initiatives (SRIs), which will form the basis of the relevant policy measures through firing up the private sector, inspiring the workforce to draw out their best, vibrant markets and greater choices, a lean and customer-focused government, escaping low income, innovation today for a better tomorrow, finding the economic sweet spots and lastly the future is bright*"**.**

Furthermore, the establishment of the National Key Economic Activities (NKEAs) is targeting the specific key sub-sectors which have the potential to thrive as the nation move into the high income bracket. The NKEAs growth could be identified of the competitive advantages, wealth of expertise and leverage on 'first mover advantage' with the potential sub-sectors include electrical and electronics, oil and gas, tourism, agriculture, green technology, financial services and information technology.

The Malaysia journey to achieve high income economy is reflected by a huge leap in the competitive ranking by 10^{th} position in 2010 compared to 18^{th} position in 2009. It could be shown in the Gross Domestic Product (GDP) growth by 7.2 per cent and productivity growth to 9.4 per cent in 2010 that was mainly driven by external demand which rushed expansion in domestic production and demand by both higher private and public spending as in Figure 2.3.

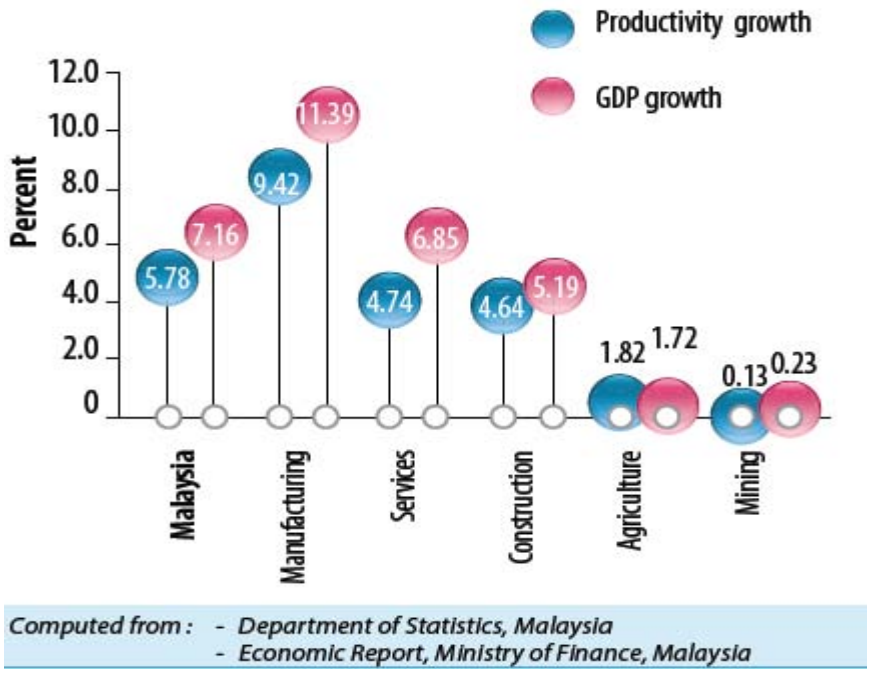


Figure 2.3: Productivity and GDP Growth of the Economic Sectors, 2010

Source: Productivity Report 2010/2011 (Malaysia Productivity Corporation, 2010c)

In 2010, the manufacturing sector's productivity level is RM 54,392, which remained below the pre-crisis levels of RM 55,349 in 2007 and RM 56,449 in 2008 as in Figure 2.4. The sector should take highly consideration to implement various productivity enhancement programs such as Quality Environment System (5S), Total Quality Management (TQM) and Innovative and Creative Circle (ICC) as a start to be competitive in the industry.

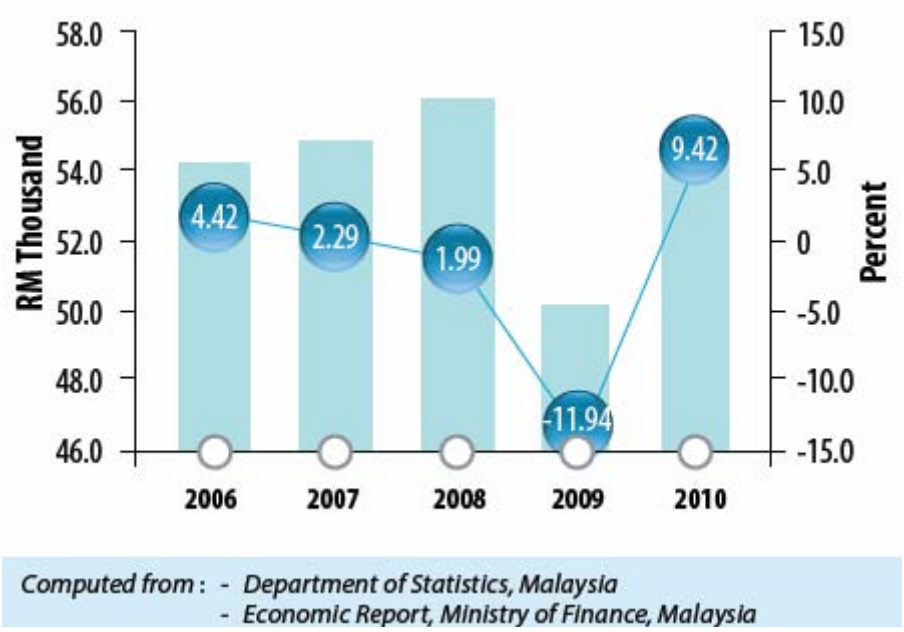


Figure 2.4: Productivity Level and Growth of the Manufacturing Sector, 2006-2010

Source: Productivity Report 2010/2011 (Malaysia Productivity Corporation, 2010c)

In NKEAs, three out of twelve that has been announced under the ETP are originated for this sector, which are electrical and electronics, refined petroleum products and palm oil based products. They will help Malaysia to achieve high income status through their contribution to the Gross National Product (GNP). The largest contributor to the manufacturing sector by 26.1 per cent of the output was the electrical and electronics (E&E) sub-sector. Furthermore, it was the huge employment with more than 40 per cent of total manufacturing labour. In order to sustain growth of E&E from China, Taiwan, Singapore and other Asian countries, specifics strategies will be formulated under the ETP.

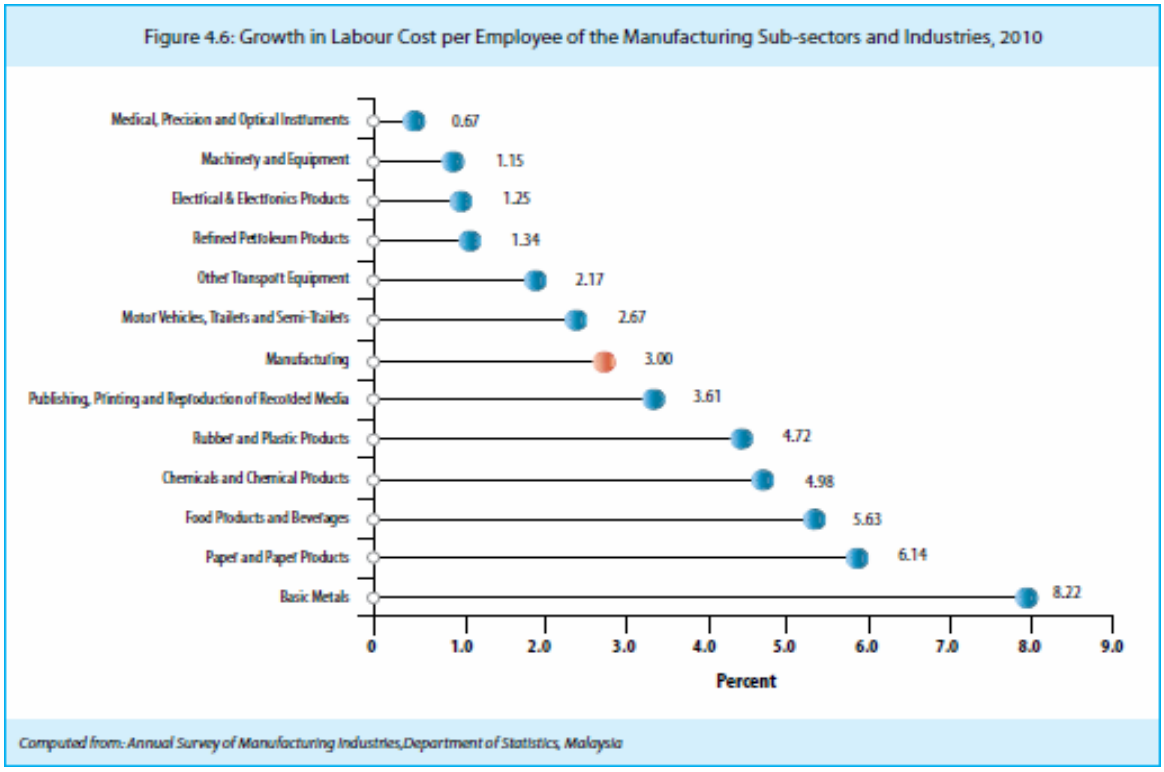


Figure 2.5: Growth in Labour Cost per Employee of the Manufacturing Sub-Sectors and Industries, 2010

Source: Productivity Report 2010/2011 (Malaysia Productivity Corporation, 2010c)

2.1 Electrical and Electronics Industry

Over the years in Malaysia it has been developing into a major global manufacturing base for electrical & electronics (E&E) industry. The E&E industry in Malaysia started in early 1970s with the Government's initiatives to promote labour-intensive and export-oriented industries. The first semiconductor plant in Penang was established in 1972 and it has developed as a contributor to Malaysia economy and become the largest industry within the manufacturing sector. Today, Malaysia's formula to attract investments based on "*a market-oriented economy*

combined with young and educated workforce, excellent infrastructure and the government committed to maintain a business-friendly environment" (Malaysian Industrial Development Authority, 2008a).

Malaysian Industrial Development Authority (2008a) stated that "*Malaysia is becoming an investment attraction to multinational companies (MNCs) from USA, Japan, Europe, Taiwan and Korea that manufacturing products ranging from semiconductor devices to consumer and industrial electronics. The industry has moved up from the value chain into the manufacture of high-end products such as fabricated wafers, mobile phones, telecommunication equipment, computer notebooks and servers, meanwhile the provision of services such as design of integrated circuits (ICs), prototyping, testing and failure analysis*".

As the leading industry within the manufacturing sector in Malaysia, the industry has contributed 31 per cent manufacturing output to the country with the gross output totalled RM166.2 billion (US$55.8 billion), 48.7 per cent on exports amounted to RM249.8 billion (US$83.8 billion) and 33.7 per cent on employment opportunities for 336,408 people. Meanwhile, USA, China and Singapore are the major export destinations and Taiwan, USA and South Korea, are the major import destinations (Malaysian Industrial Development Authority, 2008a).

A combination of factors that continued the inflow of investments, expanding and building new facilities for undertaking technology development and business support activities in Malaysia are factors such as conducive business environment, first class infrastructure, competitive package of incentives and increasingly the availability of skilled and knowledge of the workforce. The main pulling factors were (Federation of Malaysian Manufacturers, 2007):

- "Modern infrastructure and good international air, sea and cyber linkages
- Excellent trade ties with most countries
- English speaking workforce and highly skilled workers. Salaries of managerial and professional personnel are lower than those in some competing countries
- Highly trained Malaysians. This helps to speed up project implementation and enhance efficiency".

In 2010, Malaysia economic recovery was cautiously optimistic for the period ahead to shift Malaysian manufacturers towards higher-grade products that will increased demand for highly skilled designers and more experienced staff with more expatriate employment in short term and in long term is the education and training coupled with work-based schemes to provide a growing pool of local and high qualified talent.

2.1.1 Electrical and Electronics Sub-Sectors

According to Malaysian Industrial Development Authority (2008a), in Malaysia, the E&E industry is categorized into four sub-sectors such as consumer electronics, electronic components, industrial electronics and electrical products**.**

a) Consumer Electronics (Malaysian Industrial Development Authority, 2008a)

The consumer electronics comprises products that include the manufacture of LED television receivers, audio visual products such as colour television receivers, Blu-ray disc players/recorders, compact disc (CD) and video compact disc (VCD) players, digital home theatre systems, mini disc, speakers, multimedia networking devices, electronics games consoles, camcorders and digital cameras.

The production of audio visual products is projected to grow in developed countries towards the digitalization of broadcasting. The local Malaysian companies, which are original equipment manufacturers (OEMs) and original design manufacturers (ODMs), will need to promote their own brand products through networking with the MNCs in the country.

This sector is mainly represented by many renowned Japanese and Korean companies, which have contributed towards the rapid growth of the sector. The leading companies are now undertaking research and development (R&D) activities in Malaysia to support their global and Asian markets. In 2010, the exports of consumer electronic products were amounted to RM 25.8 billion (USD8.7 billion) (Malaysian Industrial Development Authority, 2008a).

b) Electronic Components (Malaysian Industrial Development Authority, 2008a)

This sub-sector encompasses a wide range of products from semiconductors devices, passive components, printed circuits and other components such as fabricated wafers, integrated circuits (ICs), IC design, capacitors, resistor, connectors, inductors, crystal quartz, oscillators, storage media, disk drive parts, printed circuit boards (PCBs) and metal and plastics parts components for E&E applications. The most important sub-sector is the electronic components and in 2010 it was accounted for 44.6 per cent of the total investment approved in the electronics sector (Malaysian Industrial Development Authority, 2008a).

Among the developing economies, Malaysia was the second largest exporter of semiconductor devices after Singapore. In Malaysia, the semiconductor companies have moved beyond basic operations such as assembly, testing and packaging of semiconductors to high value-added activities such as cutting and polishing of silicon wafers, IC design and wafer fabrication. They also have moved to complex and advanced packages to cater the demand, which are faster, smaller, leadless, high computing power and multi-functional chips. The semiconductor companies are expanding their operations with less emphasis in the manufacturing of low end products through research, design and development activities.

Nowadays, the semiconductor players is dominated by the MNCs that undertaking the assembly and test activities in this sub-sector. However, the development of the semiconductor cluster has shown a gradual increase over the years. The global trend has led this semiconductor companies in specialization and adopting new technologies such as the nanotechnology in their processes. This trend is in line with the Malaysian Government's efforts to encourage companies

to undertake value added activities and recognition to the country that has the capacity to host such activities.

This semiconductor products constituted export value of RM 97,856.5 million (US$32,837.75 million) and contributes 92.7 per cent to the total export of electronic components or 43.6 per cent of the total electronics export for 2010 (Malaysian Industrial Development Authority, 2008a).

c) Industrial Electronics (Malaysian Industrial Development Authority, 2008a)

This industrial electronics sub-sector consists of Information Communication Technology (ICT) such as computers, computer peripherals, optics and photonics, telecommunication products and other industrial electronic products such as office equipment (copier machines, fax machines, typewriters, calculators and word processors), measuring and test equipment (oscilloscopes, multi-meters and signal generators) and industrial controllers. This sub-sector is fast growing driven by rapid developments in digital and wireless technologies towards mobile technology for communications and data transfers.

In 2010, the total investment had been approved in the industrial electronics sub-sector that accounted of 24 per cent. The majority of the investments approved were from Electronic Manufacturing Services (EMS) companies producing low volume high mix products for various applications such as medical, aerospace, oil and gas and telecommunication that amounting to RM2.6 billion (Malaysian Industrial Development Authority, 2008a).

d) Electrical Products (Malaysian Industrial Development Authority, 2008a)

The electrical products sub-sector can be categorized into three segments such as industrial electrical, electrical components and electrical household appliances. Presently, there are more than 381 companies producing a wide range of products such as household electrical appliances, wire and cables, electrical industrial equipment and other electrical products.

In Malaysia, the major electrical products produced are the household appliances covers 'white goods' such as air-conditioners, refrigerators, washing machines, vacuum cleaners, microwave ovens and other small home appliances such as blenders, grinders, toasters, electric irons and electric kettles. More companies in this sub-sector are concentrating on the production of high-end products such as multi-feature air-conditioners, power motors and precision parts.

The industrial electrical equipment covers products such as electrical apparatus for power distribution and industrial lightings. It is dominated by Malaysian-owned companies catering essentially to the local power utility companies such as Tenaga Nasional Berhad (TNB), Syarikat SESCO Berhad (SESCO) and Sabah Electricity Board (SEB).

The electrical components cover products such as cables, wires and conductors, industrial parts and components. It is manufactured the major products mainly by local companies, which are wires and cables to cater the products to TNB, Telecom Malaysia and other domestic customers. These companies are also exporting the products to Indonesia, Thailand and other neighbouring countries.

The manufacturing activities have evolved from mere assembly of components and products such as coils, rice cookers and refrigerators of foreign brand to sophisticated higher value added activities including R&D, design and marketing of own brands for regional and global markets. The mainly local companies are such as Pensonic, Leader Cable and Tenaga Switchgear. For the year 2010, the capital investment in this sub-sector was amounted to RM 13.2 billion (US $4.4 billion).

2.1.2 Third Industrial Master Plan (IMP3) and the Electrical and Electronics Industry

The E&E industry is expected to maintain its position as the largest exporter of manufactures goods in the Third Industrial Master Plan (IMP3) for the period of 2006-2020. In addition, the total investments in the E&E industry are targeted to reach RM 82.4 billion, with an average annual growth rate of 7.2 per cent per annum. The E&E industry needed RM 5.5 billion per annum of investments to realize the IMP3 targets. Malaysia is on track in meeting the targets with approved investment of RM 13.29 billion in 2010 (Ministry of International Trade and Industry, 2011).

There are seven strategic thrusts have been set in IMP3 for the development of E&E industry as follows (Ministry of International Trade and Industry, 2006):

- "Strengthening and deepening the semiconductor segment
- Deepening and widening the development of the ICT industry value chain
- Intensifying R&D and design activities

- Promoting the application of new and emerging technologies
- Integrating the industry into the regional and global supply chain networks
- Making available a sufficient supply of highly skilled and innovative workforce
- Strengthening institutional support such as standards certification, management and disposal of scheduled wastes, strengthening the role of industry association and package of support schemes".

According to the strategic thrusts, there are nine strategic have been formulated to meet the challenges facing by the E&E industry such as (Ministry of International Trade and Industry, 2006):

- "Positioning Malaysia in the global supply chain networks – to identify various E&E sub-sector, such as industrial electronics, consumer electronics and semiconductors, as well as opportunities in new and emerging technologies which need to be promoted and develop
- Development of semiconductor and ICT clusters
- Limited R&D
- Shortage and mismatch of qualified human resources
- Limited global marketing networks, particularly among local companies
- Inadequate infrastructure for high technology projects which require facilities, such as uninterrupted power supply and clean water and other key related services, such as training, R&D, incubating centres, specialized testing and assistance in technical and technology development

- Managing and disposing of scheduled wastes
- The new ruling on "Green" guidelines imposed by the European Union, which could have adverse impact on the competitiveness of SMIs as the costs of compliance involved are substantial and burdensome
- Lack of certified testing and calibration centres' in Malaysia".

Malaysia needs to continue providing competitive incentive package and a conducive environment to the E&E industry to attract more investments. The main competitors are from a number of low cost emerging economies with huge domestic market such as People's Republic of China, India and Vietnam. Malaysia need to ensure by remaining competitive in the market, the number of skilled personnel and qualified workforce is sufficient and the continuously improved of Government delivery system to meet the investor's needs.

2.2 Electronics Manufacturing Services (EMS)

Electronics Manufacturing Services (EMS) is a company who is providing electronics manufacturing services for other companies where the "*EMS providers are making an important role and significantly impact on manufacturing concerns worldwide*" (Malaysian Industrial Development Authority, 2008b). According to the Analysis and Forecast for EMS Industry by IPC Market Research (2010) – Association Connecting Electronics Industries that "*the EMS sector was the last in the electronics supply chain to feel the impact of the global recession and the last to rebound in 2010. As the world's economies recover, the global EMS market is projected to grow at an annual average rate of 12.2 per cent through 2014, based on a forecast*