INNOVATION IN PENANG'S MANUFACTURING SECTOR

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INNOVATION ACTIVITIES IN PENANG'S MANUFACTURING SECTOR

Technological innovations in the manufacturing sector comprise implemented technologically new products and process and significant technological improvements in products and processes. An innovation has been implemented if it has been introduced on the market or used within a production process. The product and process has to be new to the enterprise's markets. As such, innovative companies, as defined in the OECD Oslo Manual[1] are companies that have introduced to the market at least (i) a product new to the business or a substantially improved product or product innovation; and (ii) a new or substantially improved production process through new equipment or re-engineering or process innovation.

Based on the OECD's definition, more than 40 per cent of the electronics and fabricated metal products companies that responded to this survey were innovative. The chemical & industrial chemical and plastic products companies ranked third and fourth respectively. (Table 1)

Table 1: Percentage of Respondents Involved in Innovation Activities By Selected Industries

	Product Innovation	Process Innovation	Product & Process Innovation
Electrical Machinery	44.7%	50.0%	42.1%
Fabricated Metal Products	44.4%	50.0%	41.7%
Chemical & Industrial Chemical	40.0%	45.0%	35.0%
Plastic Products	15.8%	26.3%	15.8%
Overall	34.6%	38.7%	30.9%

However, the introduction of new products and processes though may be regarded as an output measure of innovation efforts, it does not disclose the ultimate yardstick of innovation, such as whether those innovation activities were commercially viable or whether they exceeded the initial budget.

As such, a second feature used to differentiate between the more innovative and less innovative companies is through the measurement of sales and production volume. A company is considered innovative if (i) 25 per cent of its annual sales

[1] OECD, 1997, Oslo Manual, Proposed Guidelines for Collecting and Interpreting Technological Innovation Data, 2nd Edition, Paris

accounted for by its new or improved products introduced over the past three years; or (ii) 25 per cent of its production volume accounted for by its new or improved process introduced over the past three years.

About half of the companies that fulfilled the first criterion for innovative companies can be classified as innovative under the second set of criteria. (Table 2) The electronics as well as chemical & industrial chemical industries were more innovative in process innovation while the fabricated metal products companies were more innovative in product innovation. This complements their ODM status as well as the relatively higher ratio between innovation as well as R&D expenditure and sales as shown in Table 3. (See Appendix 3)

Table 2: Percentage Of Respondents With Sales & Volume Production Accounted By Innovation Activities

Improved Products/Total Sales	< 25%	25%-74%	75% & more	Total
Electrical Machinery	53.0%	41.1%	5.9%	100.0%
Fabricated Metal Products	50.0%	50.0%	0.0%	100.0%
Chemical & Industrial Chemical	75.0%	25.0%	0.0%	100.0%
Plastics Products	33.3%	33.3%	33.3%	100.0%
Overall	64.2%	31.3%	4.5%	100.0%
Improved Process/Total Volume	< 25%	25%-74%	75% & more	Total
Electrical Machinery	36.8%	63.2%	0.0%	100.0%
Fabricated Metal Products	61.1%	22.3%	16.7%	100.0%
Chemical & Industrial Chemical	55.5%	33.3%	11.1%	100.0%
Plastics Products	60.0%	40.0%	0.0%	100.0%
Overall	58.1%	32.5%	9.5%	100.0%

With a higher percentage of ODMs as well as percentage of innovative companies in product innovation among the fabricated metal products companies, it is not surprising to find that a significant percentage of these companies (24 per cent and 33 per cent respectively) spent more than 20 per cent of their annual sales on innovation activities and R&D. The electronics companies, which were perceived to be more innovative, spent a smaller proportion of their annual sales on innovation activities and R&D. On the other hand, the total amount spent on R&D and innovation by the electronics companies could be much higher than the amount spent by the fabricated metal products industry due to the size of the firms.

Table 3: Percentages of Companies According To Estimated Expenditure On Innovation Activities

Expenditure On Innovation Activities	<5%	5%-19.9%	20% and more	Overall
Electrical Machinery	50.0%	35.0%	15.0%	100.0%
Fabricated Metal Products	58.8%	17.6%	23.6%	100.0%
Chemical & Industrial Chemical	37.5%	62.5%	0.0%	100.0%
Plastic Products	40.0%	60.0%	0.0%	100.0%
Total	55.2%	32.9%	11.9%	100.0%
Expenditure on R&D	<5%	5%-19.9%	20% and more	Overall
Electrical Machinery	56.3%	31.3%	12.5%	100.1%
Fabricated Metal Products	50.0%	16.7%	33.3%	100.0%
Chemical & Industrial Chemical	50.0%	50.0%	0.0%	100.0%
Plastic Products	0.0%	100.0%	0.0%	100.0%
Total	51.8%	29.7%	18.5%	100.0%

We have discussed on innovative firms and their expenditure on innovation and R&D activities. However, why do firms innovate and why do they need to spend a significant proportion of their sales on innovation activities? It is commonly perceived that firms innovate because they need to sustain their growth and share in the global markets. However, the findings of this survey show that firms innovate because of other reasons, which actually contribute to sustainable growth and market shares.

- To improve the quality of their products;
- To reduce production cost;
- To open up new markets or increase market share
- To improve cycle time; and
- To replace products that have been phased out.

Improve The Quality Of Products

The efforts of the companies that aimed to improve the quality of their products can be seen in the type of people they employ, their expenses on training as well as the type of certifications they obtained.

More than 80 per cent of the workers in the electronic companies were categorised as skilled workers, while more than 65 per cent of the workers in the chemical & industrial chemical companies fell under the skilled labour category. About 55 per cent of the labour force in the fabricated metal products and plastic products industries were skilled labour.

However, the classification of skilled and unskilled labour is rather vague, depending on the individual companies. The extent of the training expenditure as a percentage of total payroll provides a more comprehensible picture of whether the company emphasises training. The findings of this survey show that the companies in the fabricated metal products industry spent about 6 per cent of their total payroll on training as compared with only 5 per cent in the electronics industry. (Table 4) However, it should be noted that the payroll in the electronics industry is normally higher, thus the overall expenditure on training in the electronics industry could possibly be higher than in the fabricated metal products industry.

Table 4: Training Expenditure As A Percentage of Payroll By Selected Industries

	Percentage of Payroll
Electrical Machinery	5.4
Fabricated Metal Products	6.2
Chemical & Industrial Chemical	4.0
Plastic Products	3.7
Overall	5.0

The level of innovation among the industries is also reflected in the degree of certifications obtained by the companies. The electronics and the fabricated metal industries, being more innovative than the others, were more inclined to have ISO 9001 certification, which is awarded to companies with design capabilities. As the companies in the fabricated metal products industry were mainly local-owned companies, having the ISO 9001 certification signifies the capabilities of the local labour force in design and innovation activities. The types of certification obtained by the companies also show the level of their awareness and capabilities in certain fields.

Table 5: Certification By Selected Industries

	ISO 9001	ISO 9002	ISO 14000	Others
Electrical Machinery	21.1%	60.5%	21.1%	18.4%
Fabricated Metal Products	11.1%	30.6%	2.8%	16.7%
Chemical & Industrial Chemical	5.0%	65.0%	15.0%	20.0%
Plastic Products	0.0%	42.1%	0.0%	0.0%
Total	8.9%	44.0%	6.3%	12.6%

Note:
Others include QS 9000 and other SIRIM certifications

Reduce Production Cost

Companies perceived that they could reduce their production costs if they innovate through the adoption of labour-saving equipment as well as those that can reduce throughput-time from the front-of-line till the end-of-line. Automation could also reduce defects and assure quality control and management.

Open Up New Markets Or Increase Market Share

Average sales per company among the respondents have increased in general between 1996 and 1999. The electronics companies achieved the highest growth in terms of average sales per company, higher than the average for all industries. The fabricated metal products companies also achieved a growth rate higher than the average for all industries during the same period. By opening up new markets, the companies anticipated that their sales would further increase.

Table 6: Average Sales Per Company By Selected Industries

	1996	1999	% Growth P.A.
Electrical Machinery	199.85	376.00	23.5%
Fabricated Metal Products	16.65	28.53	19.7%
Chemicals & Industrial Chemicals	64.40	84.69	9.6%
Plastics Products	10.28	11.42	3.6%
Average for all respondents	74.41	121.64	17.8%

Presently, other than the electronics and chemical & industrial chemical industries, a significantly high percentage of companies in the fabricated metal products and plastic products industries are selling to customers in Malaysia. (Table 7) With the introduction and implementation of trade liberalisation and WTO, companies have to grow global. As such, it is very important for the companies that are still selling locally to penetrate and increase their market share in the global market.

Table 7: Market Shares By Selected Industries

	Malaysia	Other Asean	Other Asia	ROW	Total
Electrical Machinery	18.7%	6.3%	12.10%	63.0%	100.10%
Fabricated Metal Products	78.2%	3.4%	7.20%	11.2%	100.00%
Chemical & Industrial Chemicals	30.2%	10.9%	44.10%	14.7%	100.00%
Plastics Products	76.0%	4.3%	4.00%	15.7%	100.00%

Improve Cycle Time And Replace Products That Are Being Phased Out

To improve cycle time is to improve on the throughput-time for production as well as time-to-market. This requires automation as well as time- and labour-saving equipment and devices. In short, this involves process innovation. On the other hand, to replace products that are being or have been phased out is to have product innovation. Both innovation activities not only require skilled and qualified labour but also a pool of R&D engineers.

Most of the R&D personnel in Penang were employed in the electronics companies as shown in Table 8. The average number of R&D personnel per firm in the electronics companies also far exceeded that in the other industries. The fabricated metal products companies, though most of them being ODMs did not have a high ratio of R&D personnel per firm. This could be possibly due to the size of the fabricated metal products firms. More than 85 per cent of the companies in the fabricated metal products industry have fixed assets of less than RM 25 million compared with only about 54 per cent of the companies in the electronics industry.

Table 8: Distribution of R&D Employees and R&D Employees Per Firm By Selected Industries

	R&D Employees as % of Total R&D Employees	Average Number of Employees/Firm
Electrical Machinery	51.1%	20
Fabricated Metal Products	8.0%	4
Chemical & Industrial Chemical	4.7%	5
Plastic Products	2.1%	6
Total	100.0%	11

It is undeniable that manufacturing companies in Penang are carrying out various forms of innovation activities. The most widespread among the various innovation activities are the acquisition of machinery, equipment & software linked to product and process innovation; training directly linked to technological innovations as well as R&D activities. The three key activities in one way or another helped to improve the quality of the products; reduce production cost; improve cycle time and replace products that are being/have been phased out. Subsequently, by achieving these four objectives, is highly possible for the companies to open up new markets and/or to increase their market share.

ISSUES & CHALLENGES

Less than half of the companies that carried out innovation activities encountered problems in their innovation projects. A higher percentage of the electronics and chemical & industrial chemical companies were observed to encounter problems compared with the companies from the other industries as shown in Table 9.

Table 9: Percentage of Companies That Encountered Problems in Innovation By Selected Industries

	% Of Companies That Encountered Problems
Electrical Machinery	35.0%
Fabricated Metal Products	26.3%
Chemical & Industrial Chemical	40.0%
Plastic Products	20.0%
Overall	29.6%

The factors or issues that affected innovation projects mainly encompass the following:

- Lack of qualified personnel,
- Perceived costs too high
- Perceived risks too high
- Lack of access to financing
- Lack of information on technology
- Internal resistance to innovate
- Organisational rigidities

Lack of Qualified Personnel

Some of the high-tech companies in Penang, especially those in the electronic industry have more than 25 per cent of their workforce accounted for by degree holders. However, findings from the survey show that slightly less than 10 per cent of the workers in the electronics companies were degree holders. On the other hand, more than 68 per cent of the workers of the companies in these four innovative industries have only school certificates. This indicates that the labour force in Penang's manufacturing sector is still relatively low-end, with only a fraction of them who are highly skilled and qualified. In fact, some high-tech companies also indicated that it is rather difficult to recruit qualified and experienced personnel to fill up vacancies at the top 10 per cent of the organisation.

Table 10: Academic Qualification of Workforce In Selected Companies

	Degree	Diploma & Certificate	Primary & Secondary School Certificate	Total
Electrical Machinery	9.50%	22.00%	68.50%	100.00%
Fabricated Metal Products	5.30%	8.90%	85.90%	100.10%
Chemical & Industrial Chemical	10.90%	17.90%	71.20%	100.00%
Plastic Products	2.50%	7.30%	90.20%	100.00%
Overall	8.20%	17.60%	74.20%	100.00%

Perceived Costs Too High

Many of the firms perceived the costs of innovation to be too high. The companies having problems with high costs of innovation normally could not complete their projects within the original budget. This could be mainly due to the low budget allocation for the proposed innovation project, and once the project is launched, the expenses exceeded the original budget.

Table 11 shows that 40 per cent or more of the companies only managed to implement up to 49 per cent of their innovation projects within the original budget. A higher percentage of companies from the fabricated metal products and plastic products industries fell under this category. A higher percentage of companies from the electronics (37 per cent) and chemical & industrial chemical (30 per cent) were observed to implement up to 75 per cent or more of their innovation projects within the original budget.

Table 11: Distribution of Companies According to Percentage of Innovation Projects Implemented Within Original Budget

	< 50%	50%-74%	> 75%	Overall
Electrical Machinery	42.10%	21.10%	36.80%	100.00%
Fabricated Metal Products	77.70%	11.10%	11.10%	100.00%
Chemical & Industrial Chemical	50.00%	20.00%	30.00%	100.00%
Plastic Products	75.00%	0.00%	25.00%	100.00%
Overall	52.00%	18.20%	29.90%	100.10%

Perceived Risks Too High

Other than costs, many companies also perceived that the risks they have to endure are too high. These are in the form of long payback period and/or the low success rate in commercialising their products.

Normally, the more complicated the innovation project the longer the payback period. This is because the project will take a longer time to fully materialise. Table 12 shows that only 10.5 per cent of the electronics companies managed to obtain their return of investment within the first 6 months. The plastic products companies that have innovation projects that are relatively less complicated registered a higher percentage of firms that achieved a shorter payback period.

Table 12: Distribution of Companies According To Average Payback Period By Selected Industries

	< 6 mths	7-12 mths	1-3 years	> 3 years	Overall
Electrical Machinery	10.5%	31.6%	47.4%	10.5%	100.0%
Fabricated Metal Products	12.5%	25.0%	62.6%	0.0%	100.1%
Chemical & Industrial Chemical	0.0%	11.1%	66.7%	22.2%	100.0%
Plastic Products	33.3%	33.3%	33.3%	0.0%	100.0%
Overall	9.7%	20.8%	58.3%	11.1%	100.0%

Generally, more than 50 per cent of the firms, except for the electronics firms (35 per cent) only managed to successfully commercialise less than 50 per cent of their new products. A higher percentage of electronic companies, on the other hand, managed to successfully commercialise up to 75 per cent or more of their new products.

Table 13: Distribution of Innovative Companies According To Percentage Of New Products That Were Successful Commercially

	< 50%	50%-74%	> 75%	Overall
Electrical Machinery	35.30%	17.60%	47.10%	100.00%
Fabricated Metal Products	66.70%	20.00%	13.30%	100.00%
Chemical & Industrial Chemical	50.00%	25.00%	25.00%	100.00%
Plastic Products	75.00%	0.00%	25.00%	100.00%
Overall	54.60%	13.60%	31.80%	100.00%

Lack Of Access To Financing

The local-owned companies, particularly the fabricated metal products companies, encountered this problem. The chemical & industrial chemical companies also encountered this problem because by nature of the industry, there are several regulatory conformities. In addition, this industry is also more capital-intensive than the other supporting and ancillary industries and majority of these companies are also local-owned. Being small (compared with the multinational electronics companies) and lack resources, particularly assets, these companies face difficulties in acquiring financing.

Lack Of Information On Technology

The main sources of information for innovation are clients; within the enterprise, parent/associate companies, suppliers, fairs & exhibitions and the Internet. While all the industries depended on their clients as the main source of information on innovation, most of them also depended on information within their own enterprises. The electronics companies, which are mainly wholly foreign-owned, also depended on their parent/associate companies. On the other hand, the plastic products and chemical & industrial chemical companies depended on their suppliers, particularly their foreign suppliers. Local companies also attended fairs and exhibitions as well as sourced for information from the Internet.

Some clients provide good sources of information on innovation, especially if the clients are global companies. The demand conditions imposed by these clients would help enhance local capabilities. Parent companies also provide excellent information because they are mostly the technological hubs for the companies concerned. Suppliers, especially foreign ones that are global suppliers may be a good source for superior technologies. However, local suppliers, particularly the second- and third-tier suppliers would normally depend on their customers for information rather than sharing information with them.

On the other hand, companies that have to depend on information from fairs and exhibitions as well as the Internet may not acquire the state-of-the-art as well as privileged and elite technologies as these technologies have already been made available to the public.

Universities and research institutes are normally the focus of innovative ideas and activities. However, in the case of Penang, these two sources were the least utilised by the innovative companies. This could be due to the lack of a conducive environment for innovation activities at those institutes, lack of R&D personnel, outdated mode of research methodology used as well as lack of interest among the institutes to upgrade themselves to meet the requirements of the companies.

Internal Resistance To Innovate & Organisational Rigidities

Internal resistance to innovate could be due to the perception of the workforce itself. The unskilled and semi-skilled workers would normally resist innovation because they are concerned about keeping their jobs. These workers were apprehensive because they fear that machinery & equipment would replace them. In addition, complacency also resulted in internal resistance to innovate. A complacent worker would not be too keen to upgrade his skills and capabilities to meet new challenges.

On the other hand, the organisational behaviour for innovation in the innovative companies is characterised as:

- Highly supportive top management;
- Management that strongly advocates the use of IT in innovating business processes;
- Management that tolerates failure and encourages their staff to learn from mistakes; and

- A compensation system that is oriented towards rewarding employees for being innovative.

However, while the management of these companies were very supportive of innovation, the employees are not very open to changes as shown in their resistance to innovation. The nonflexible rules of the companies through their provision of share options have indirectly created the reluctance to innovate among the workers. Although it is perceived that employees who are innovative will be rewarded through the companies' compensation system, there are qualms about partiality in the system. Table 14 shows that while some companies offered share options to all employees, some didn't. The feeling of dissatisfaction may arise in the case where all the employees were given share options but some employees worked harder and smarter than the rest. In the case where share options were given on a selected basis, favouritisms could also arise.

Table 14: Percentage of Innovative Companies That Provide Employee Share Option/Share Ownership Programme

	% of Innovative Companies	For Selected Personnel Only	For All Employees
Electrical Machinery	60.0%	72.7%	27.3%
Fabricated Metal Products	21.1%	75.0%	25.0%
Chemical & Industrial Chemical	40.0%	0.0%	100.0%
Plastic Products	50.0%	50.0%	50.0%
Overall	35.8%	57.1%	42.9%

While we have discussed the issues and problems faced by the top 4 innovative industries in Penang, we should also bear in mind that the other industries that accounted for the remaining 40 per cent of the manufacturing companies in Penang are facing even more crucial issues that prevent them from being innovative. In addition to the issues encountered by the innovative industries, the less innovative ones also encountered problems like lack of information on markets and excessive government regulations.

COOPERATION IN INNOVATION ACTIVITIES

The innovative companies normally cooperate on innovation activities with external parties. There are various reasons why these companies cooperate and they include:

- To enter into new technology fields;
- To enable the transfer of know-how;
- To have a faster time to market; and
- To establish long-term strategic partnership.

The innovative companies mainly cooperate with their customers/buyers; suppliers, parent/associate companies as well as technical service providers on product development. The electronics companies mainly cooperate with their parent/associate companies while the fabricated metal products and plastic products companies, which are mainly local-owned, cooperate with their local suppliers as well as their technical service providers.

A distinct change is observed among the electronics companies in their innovation partners on process innovation. The electronics companies depended less on their parent/associate companies but more on their local suppliers in this area of cooperation. This is not surprising because the electronics companies in Penang are deemed to possess better process technologies than their associate companies overseas. In addition to the types of innovation partners on product development, local-owned companies, particularly those in the plastic products industry also cooperate with their business service providers on process innovation.

A brief overview of the location of the innovation partners of these companies indicates that most of them are located in Asia. This shows that proximity to customers and partners is very important to ensure success in any innovation partnership, especially in encouraging faster time to market as well as establishing long-term strategic partnerships.

Despite the fact that it is important for the companies to establish cooperation with their innovation partners, some of these companies indicated that they face problems in collaborating with their external partners. The problems include:

- Overrun of budgeted cost;
- Unintentional knowledge leakage;
- Difficulty in coordination;
- Differing capabilities; and
- Confidential relation/secrecy.

Two of the five problems encountered by the companies were related to confidentiality of information. Most of the time, these are results of human errors. As such, it is very important to ensure that the personnel handling such affairs are properly trained. The issue of lack of qualified personnel discussed earlier is a priority area for improvement.

Expenditure that exceeded the initial budget has been discussed earlier as one of the issues that affected innovation activities. This could indirectly resulted in higher cost for conducting innovation activities.

Problems in coordination could be a result of the distance between the partners, contradicting interests and capabilities among partners, as well as the frequency of communication between partners. As discussed earlier, most of the innovation partners of these companies were located in Asia, thus bridging the communication gap, allowing for better communication and visits among partners. Although the use of Internet has increased the frequency of communication between partners, visits are still considered as an important element in communication. The closer the partners are with each other, the more frequent the visits could be made.

IS PENANG A FAVOURABLE LOCATION FOR INNOVATION?

The determining factors that encourage companies to locate their innovation activities at a certain location do not only rest on the capabilities of the local labour force but also on other important factors. These factors as indicated by the companies as favourable include:

- Openness of customers to innovation;
- Openness of suppliers to innovation;
- Quality of telecommunication & IT services for enabling innovation;
- Openness of government departments & regulatory authorities to innovation;
- Attitude of people towards innovation; and
- Availability of consultancy support services.

On the other hand, the key factor, which hinders the efforts to make Penang a favourable location for innovation is the high tolerance for failure. This includes slow response by the government agencies and local workforce, high cost of implementing innovation and utilities breakdown, including electricity. A change in the attitude of the local labour force to be more receptive to change and innovation as well as to expedite responses and procedures would help alleviate this problem.

POLICY IMPLICATIONS

All manufacturing projects licensed under the Industrial Coordination Act 1975 are required to obtain prior written approval of the Ministry of International Trade and Industry (MITI) before entering any technology transfer involving foreign partners. The purpose of this requirement is to ensure that the agreement does not impose unfair and unjustifiable restrictions or handicaps on the local party, the agreement will not be prejudicial to national interest and the payment of fees will commensurate with the level of technology to be transferred.

Under these arrangements specific agreements could be in the form of:

- Joint-venture Agreement to set up a joint-venture company between two or more parties involving locals and foreigners.
- Technical Assistance and Know-how Agreement between two or more parties where one party will provide the technical assistance and know-how for the manufacture of certain products for a certain amount of fee or royalty.
- Licence Agreement between two or more parties where the licensor grants a licence/right to the licensee to use its patents, trademark and other industrial/intellectual properties for the manufacture of certain products for a certain amount of fee or royalty.
- Patent and Trademark Agreement between two or more parties where one party gives the right to the other to use its patents and trademarks for the manufacture of certain products for a certain amount of fee.
- Turnkey Contract between two or more parties where the contract is awarded to one of the parties to perform all stages from the initial to the final stage,

inclusive of consultancy, managerial, technical and other services, until the contractual project is ready for immediate commercial production or final use.
- Management Agreement between two or more parties where one party will provide management services to the other for a management fee.

In terms of incentives, the Federal Government grants Incentives for R&D. Three types of R&D incentives are given to qualifying firms. These incentives include:
- Contract R&D Company: This incentive is given to a contract R&D company that provides R&D services in Malaysia to a company other than its related companies. The incentive package includes Pioneers Status (PS) with full tax exemption at statutory income level for five years or an Investment Tax Allowance (ITA) of 100 per cent on qualifying capital expenditure incurred within 10 years. The ITA can be utilised to offset against 70 per cent of the statutory income in the year of assessment.
- R&D Company: This incentive is given to a company that provides R&D services in Malaysia to its related companies or to any other company. The incentive package includes ITA of 100 per cent on qualifying capital expenditure incurred within 10 years and can be utilised to offset against 70 per cent of the statutory income in the year of assessment. The related companies concerned, however, will not enjoy double deduction for payments to the R&D company for the use of its services unless the R&D company opts not to avail itself of the ITA.
- In-house Research: This incentive is given to a company, which carries out in-house research in Malaysia, for the purpose of the company's own business. The incentive package includes ITA of 50 per cent on qualifying capital expenditure incurred within 10 years and can be utilised to offset against 70 per cent of the statutory income in the year of assessment.

In order to be eligible for the incentives for Contract R&D Company and R&D Company, the companies must have at least 50 per cent of the workforce accounted for by appropriately qualified personnel performing research and technical functions. In addition, at least 70 per cent of the income of the company should be derived from R&D activities and the research undertaken must be in accordance with the needs of the country and bring benefits to the Malaysian economy.

In addition to the R&D incentives, the government also grants double deduction for R&D. This double-deduction comes in three forms, namely:
- Double deduction on revenue (non-capital) expenditure incurred by a company on research directly undertaken, which is approved by the Ministry of Finance.
- Double deduction on payment for the use of services of approved research institutes, R&D companies or contract R&D companies
- Double deduction on cash contributions made to approved research institutions.

Although these two sets of incentives are made available to qualified applicants, it should be noted that each incentive is given only at any one time and a company will not benefit from both the R&D incentives and double deduction at the same time.

Other funds and programmes aimed at assisting Malaysian companies to acquire technologies include the Industrial Technical Assistance Fund (ITAF) for the small-and medium-industries (SMIs), the Technology Acquisition Fund (TAF), the Commercialisation of Research & Development Fund (CRDF) and the Industrial Grant Scheme (IGS).

Table 15: Wish List By Selected Industries & Equity Structure

Type of Industry	Equity Structure	Suggestions
Electrical Machinery	100% foreign	1. Provide cash grants & special awards 2. Organise Innovation Harvesting Campaign 3. Publicise innovation activities to create awareness 4. Provide more incentives 5. Reduce taxes 6. Government sponsored R&D institutions to help smaller companies 7. Upgrading the technical capabilities of local universities to match the technological needs of industries (eg optical design, RF module design) then reach out to the potential industries 8. Reduce red tapes
	< 50% local	1. Organise expositions for innovative works 2. Establish research institutes and commercialise innovative works
	50%-70% local	1. Provide attractive incentives 2. Provide technical support
	100% local	1. Provide easy access to R&D facilities and government incentives (like R&D funding) for innovation activities 2. Set up an independent body to govern the R&D (private) facility. 3. Provide awards 4. Establish forum for innovation activities
Fabricated Metal Products	100% foreign	1. Reduce corporate tax 2. Provide incentives & tax rebates to promote innovation environment
	50%-70% local	1. Establish Innovation Fund to fund R&D activities
	100% local	1. Need to make available a pool of skilled manpower in the field of R&D and innovation. 2. More incentives schemes and financial support 3. Eliminate red tapes 4. Provide subsidies/financing for innovation activities for SMIs to compete with international suppliers 5. Conduct free training for technical and management training to new companies and companies that lack financial support. 6. Bring together related industries to work on re-engineering & enhancement of products through relevant studies. 7. Provide high technology equipment & organise trade fairs & exhibitions to introduce advanced technical knowledge & technology from other countries.
Chemical & Industrial Chemical	100% foreign	1. Provide better incentives, suitable manpower and facilities.
	< 50% local	1. Provide awards & incentives
	> 70% local	1. More human resources development on innovation activities
	100% local	1. Need to improve on education & attitude of the people, customers and suppliers towards innovation.
Plastic Products	100% local	1. Need for awareness programmes on innovation 2. Reduce the number of requirements and regulations pertaining to the attainment of new innovation and information. 3. Establish more institutions & research centers 4. Provide incentives as well as technical & financial support to encourage innovation activities

While the government has prepared and provided a wide range of incentives and programmes to encourage innovation activities, the companies that responded to this survey perceived that these incentives and programmes are not sufficient to further promote innovation activities. The wish list of these companies according to the types of industry and equity structure is shown in Table 15 above.

Most of the suggestions given by the companies that responded were rather vague or are already being implemented by the government. In addition, some of the suggestions would be more effective if they are private sector or market-driven. However, it is also rather accurate that the application and approval procedure for government incentives and funding is rather lengthy and involves a lot of bureaucratic red tapes. The government, on the other hand, in recent years have tried to reduce the red tapes and shorten the processing time for these applications.

A very useful suggestion here is to upgrade the technical capabilities of the local universities to match the technological needs of the high-tech industries. This would greatly enhance efforts to promote innovation activities in Penang. Majority of the innovative companies are currently not using the local universities and research institutes for their innovation activities as discussed earlier, and the reason for not doing so could be the lack of technical capabilities.

Another useful suggestion is to establish forum for innovation activities. Several forums have been established over the past decade to deliberate on industrial, human resource, SMI, trade and other issues. However, none of these forums have innovation issues in their agenda. It would be an advantage to increase the scope of one of these forums to include deliberation on innovation activities.

In any kind of development, human capital appears to be the most essential. As such, skills upgrading of the local labour force is of utmost importance. Essential human resource development on the necessary skills to meet the requirements of the industries would be able to build a pool of suitable manpower to take on innovative activities.

SUGGESTIONS & RECOMMENDATIONS

There are three basic areas for any development and to further promote innovation in Penang's manufacturing sector, the enhancement of these three areas is most necessary.

Human Capital:

Human capital in this regard refers to human resource development, not only in skills upgrading and acquisition of higher qualifications but also in terms of work ethics and attitude towards change.

One of the most important areas for development is to increase the proportion of degree holders, particular in science and technology, including post-graduate degree holders in the companies. An increase in the number and percentage of degree holders would enable the firms to move forward towards the technology era. By doing so, there is a higher probability that the innovative products would be more successful commercially. This is mainly because the main criteria for sales success are quality and on time fulfilment.

Physical Infrastructure Development:

Physical infrastructure development in respect to innovation refers to the provision of state-of-the-art laboratories to cater to smaller companies that could not justify for the cost to set up their own innovation facilities. As can be seen from the wish list, some of the companies, particularly the local ones, still perceive that there is insufficient supply of institutes for research and technical training. Although these institutes are already available in Penang, there is a need to continuously upgrade the facilities in these institutes to meet the requisite conditions of high-tech global companies and customers.

Government's Role In Facilitating Innovation

The government will have to play a major role in facilitating innovation activities in Penang. While incentives are given at the national level, the State Government could assist the innovative companies, especially the local-owned ones to recruit suitably qualified people, acquire the necessary incentives and to solve any probable problems encountered by these companies in their quest to innovate. In addition, the government could also play a role in disseminating information on innovation to the manufacturing community.

It would be an advantage to all the manufacturing companies in Penang, particularly the SMIs and local-owned ones, if the government could establish a forum to deliberate on innovation issues, development and activities as well as a special task force to identify innovative ideas as well as new and emerging technologies. The SMIs as well as the local companies would benefit from these efforts as most of them lack information on technology.

APPENDIX 1: INTRODUCTION

Innovation activities are perceived as a significant engine for economic growth. Both the industrialised and industrialising countries are very dependent on the ability of their populace and labour force to continually develop and produce innovative products and processes in order to sustain economic and business growth. The advent of trade liberalization and globalisation has further advocate the need for greater innovation as well as capabilities to absorb, adopt and adapt higher technologies and know-how. In short, if the country and its firms are more innovative, it is more apparent that the country is more technologically advanced.

Innovation, in respect to this paper, refers to innovation activities within the manufacturing sector. The activities are categorised as product innovation and process innovation. Product innovation encompasses the essential improvement of an existing product or the proliferation of an entirely new product. Process innovation, on the other hand, encompasses the essential enhancement of the existing production process or the development of a completely new production process.

Penang, which is very dependent on its export-oriented manufacturing sector, has to adhere to the global technological trends in order to sustain its economic growth and to build it competitiveness in the global export market. As such, it is very important for manufacturers in Penang, particularly the export-oriented industries to constantly update and upgrade themselves with the latest technologies as well as to innovate to create a niche for themselves in the global markets.

However, to date, very few studies have been conducted to gauge the level of innovation among manufacturers in Penang. With this in mind, the Socio-economic & Environmental Research Institute (SERI) conducted the Penang State Innovation Survey in 2000, in collaboration with the Department of Economic Geography of the University of Hannover, Germany. SERI deems this survey to be crucial for Penang because it enables the assessment of past achievements as well as highlight future challenges for the State. This is mainly because, innovation activities, namely the development of new products and production processes are key factors influencing Penang's trajectory towards a fully developed state.

APPENDIX 2: BACKGROUND OF STUDY

Appendix 1 has clarified the rationale for conducting the Penang State Innovation Survey. As such the objectives for the survey as well as this paper is to assess the state of innovation among the manufacturing companies in Penang as well as to identify issues and challenges that the Penang-based manufacturers encountered in their quest to innovate. Lastly this paper also attempts to highlight relevant policy implications.

The survey commenced in June 2000 and questionnaires were sent to 951 manufacturing firms in Penang, which cover a wide range of industries. The addresses of these firms were compiled from various sources, which include the Penang Development Corporation (PDC), North Malaysia Peninsular Small & Medium Enterprise Association (SAMENTA), Small and Medium Industry Centre (PIKS), Association of Prai Industrial Companies (APIC), Federation of Malaysian Manufacturers (FMM) as well as SERI.

The companies were given a period of one month to respond to the survey. However, the responses were rather disappointing. Only a 10.5 per cent response rate was achieved after the one-month period. Hence, a second round of survey questionnaires were sent out during the second-half of July 2000. The companies were given another one month to respond and by the end of the period, a response rate of 20.7 per cent was achieved. Telephone follow-ups were made to canvass for replies, to clarify doubtful or contradictory responses as well as to obtain missing data. In some cases, the responses have to be removed.

Box 1:

Total number of questionnaire sent out:	951
Number of questionnaires bounced back:	23
Unrelated (e.g. non-manufacturing) questionnaires:	7
Total number of questionnaires delivered:	921
Returned questionnaires:	200
Invalid responses (e.g. missing data):	9
Valid responses:	191
Response rate:	20.7%

APPENDIX 3: PROFILE OF PENANG'S MANUFACTURING SECTOR

The electronics industry, being the dominant industry in Penang, was the largest group of respondents to the survey, accounting for almost 20 per cent of the respondents. The other three larger groups of respondents were from the fabricated metal products industry (19 per cent), chemical & industrial chemical products industry (10 per cent) and plastic products industry (10 percent). As the top four industries accounted for almost 60 per cent of all the respondents of this survey, this paper will emphasise the electronics industry and its supporting and ancillary industry, namely the other three industries.

Findings from the four industries are perceived to be representative because they correspond with the structure of the manufacturing sector in Penang. Data from the PDC 1999 survey shows that the top four industries accounted for 62 per cent of the companies in PDC areas. (Table 3.1)

Table 3.1: Structure Of Penang's Manufacturing Sector (% of total)

	Survey	PDC
Electronics	20	21
Fabricated Metal Products	19	22
Chemical	10	8
Plastics Products	10	10
Total for the 4 Industries	60	62

The electronics, industry as evidenced in the history of Penang's industrialisation process is predominantly foreign-owned. Almost 60 per cent of the respondents from the electronics industry were wholly foreign-owned companies while only 24 per cent were wholly local-owned. On the other hand, majority of the companies that fall under the fabricated metal products and plastic products industries were wholly local-owned. Only about a quarter of the companies in the fabricated metal products and chemical & industrial chemical products industry were wholly foreign-owned, while none of the companies in the plastic products industry were wholly foreign-owned.

Despite the fact that majority of the electronics companies were wholly foreign-owned, a smaller percentage of them actually need to report to their World Headquarters (WHQ). This implies that many of the electronics companies in Penang were given the mandate to operate and make their own decisions. This also signifies the confidence of the HQs in our local management and labour force. Similar situations were observed in the other companies although majority of them were local-owned.

Table 3.2: Comparison Between Equity Structure And Reporting Situation

Equity Structure	100% foreign	Local-foreign j.v.	100% local
Electrical Machinery[2]	58%	19%	24%
Fabricated Metal Products	22%	9%	69%
Chemical & Industrial Chemical	25%	40%	35%
Plastic Products	0%	21%	79%
Reporting to:	WHQ	RHQ	No Reporting
Electrical Machinery	55.3%	15.8%	28.9%
Fabricated Metal Products	30.6%	5.6%	63.9%
Chemical & Industrial Chemical	30.0%	25.0%	45.0%
Plastic Products	47.4%	5.3%	47.4%
All Industries	40.3%	13.6%	46.1%

Majority of the companies that responded to this survey carried out manufacturing activities in Penang. However, a bigger percentage of the electronics firms (47 per cent) compared with the firms in the other three industries carried out more value-adding activities like setting up their Regional Headquarters (RHQ), research & development (R&D), procurement, sales/marketing as well as customer support. A bigger percentage of companies in the fabricated metal products industry (40 per cent) also carried out more value-adding activities than the companies in the chemical & industrial chemical and plastic products industries. The plastic products companies were the least value adding among the four industries (83 per cent in manufacturing activities).

In terms of types of product, although the majority of the companies were producers of intermediate goods/components, a bigger percentage of the electronics companies (76 per cent) compared with the rest were actually involved in this type of product. This indicates that most of the electronics companies were either subsidiaries or manufacturing arms of foreign-owned companies or were original equipment manufacturers (OEM) of foreign-owned customers.

A relatively small percentage of companies in these four industries were producers of raw materials, consumer goods, and capital goods as well as providers of system solutions. This information correlates with the findings on the categories of their sales. The electronics companies were mainly manufacturing arms or OEMs with a negligible percentage of them being original design manufacturers (ODM) and own brandname manufacturers (OBM). The fabricated metal products companies, on the other hand were mainly ODM, signifying local capabilities in technology and design competency.

2 The electrical machinery sector refers to the semiconductor & electronic components, computer & peripherals, communication equipment, consumer electronics, electrical apparatus and electrical appliances segments. For the purpose of this paper, this sector shall be referred to as 'electronics industry' in the rest of the report, except in the tables, because the electrical sector accounted for less than 8 per cent of the respondents.

Table 3.3: Types of Products And Categories of Sales By Selected Industries

Types of Products	Raw Materials	Intermediate Goods/ Components	Consumer Goods	Capital Goods	System Solutions	Overall
Electrical Machinery	0.0%	76.3%	18.4%	0.0%	5.3%	100.0%
Fabricated Metal Products	0.0%	60.0%	17.1%	17.1%	5.7%	100.0%
Chemical & Industrial Chemical	20.0%	60.0%	20.0%	0.0%	0.0%	100.0%
Plastic Products	0.0%	68.4%	26.3%	5.3%	0.0%	100.0%
Categories of Sales	Mfg Arm	OEM	ODM	OBM	Others	Overall
Electrical Machinery	49%	44%	2%	5%	0%	100%
Fabricated Metal Products	7%	15%	71%	6%	1%	100%
Chemical & Industrial Chemical	57%	3%	4%	36%	0%	100%
Plastic Products	15%	73%	10%	2%	0%	100%