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ABSTRACT

Currently specific infrastructures for industrial wastes recovery are not well establish in Malaysia as stakeholders often focus on the physical infrastructure for treatment and disposals of industrial wastes. For the past four decades these approaches resulting in many environmental problems such as illegal dumping, illegal export and import of wastes. However with new technology development and increasing commitment, many types of industrial wastes have been recovered through recycling of waste. Solid and hazardous waste recovery contributed significantly to economic benefits and environmental protection. Amount of industrial hazardous waste recovery shows an increasing trends in Malaysia. 120, 570 metric ton were recovered in year 2000, the amount increased to 272, 419 metric ton in 2004. However in 2005 the amount of waste recovered decreased to 149,569 metric ton. Between year 2000 to 2005, 1.12 million metric ton of industrial hazardous waste have been recovered, with estimated value of RM 4.48 billion. To ensure sustainability of industrial wastes recovery, a good infrastructure support is needed. The infrastructure help to accommodate increasing demand of wastes for recovery and its end product as well as to minimize environmental problems. The infrastructures required for sustainable industrial waste recovery in Malaysia are the physical, governance and the economic infrastructures. The physical infrastructure includes support for recovery activities by the generator, the transporter and the recycler, technology development and application, as well as efforts for human resource development. The governance infrastructure also plays an important role, as it provides the infrastructure for good management to minimize environmental and human impacts. The economic infrastructure includes financial mechanisms and economic tools to ensure efficient wastes recovery activities. These infrastructures should be in place to achieve sustainable industrial wastes recovery in Malaysia.

Keywords: recovery, infrastructure, governance, industrial waste, sustainability.

Introduction

Manufacturing industry plays an important role for Malaysia's economic growth for the past three decades. This sectors contribution to Malaysia GDP grows from 13.9% in 1970 to 31.9% of overall GDP in the year 2000 (Malaysia, 2006). Malaysia continues to maintain the manufacturing industry as the main sector for development process and economic growth. However industrial activity generates huge amount of wastes. The existing management systems in Malaysia for industrial wastes gives priority to end-of-pipe approach, promotes the use of treatment and disposal method, rather than recovery. But this approach has been found creating many environmental problems such as new land requirements for disposals, and illegal dumping (Table 1).

Table 1: Reported Incidents of Hazardous Wastes Illegal Disposals in Malaysia

Year	Location	Amount and Type of Wastes	Company
1989	Pantai Remis, Perak	1,500 tonnes of toxic wastes	Unknown
1993	Bukit Merah, Perak	Radio active wastes	Asian Rare Earth Plant, Mitsubishi Kasei.
1995	Pangkor Island, Perak	Forty-one drums of highly toxic potassium cyanide	Unknown
1995	Penang Island	28 drums of trichiorofluoromethane	unknown
2001	Ulu Tiram, Johor	1,000 tonnes of metal ashes	Foreign-based smelting company
2003	Ijok, Selangor	500 drums of paint sludge and glue.	Unknown

Source: Recycling Point Dot Com (2003), The Star, (2003)

The current management approach needs to be changed towards a more sustainable management regime as there are now technology and demand to recover the waste for other uses. For example, Japan emphasizes recovery of waste and by-products through implementation of strategies to replace material resources with technology development (Erkman, 2002). Pongrácz and Pohjola, (2004) emphasize the importance of resource conservation towards achieving more sustainable waste practice. Wastes recovery allows industry to reduce manufacturing process costs, increase efficiency of resources utilization, promotes environmental friendly product design and most important to reduce impacts on the environment and human health. Recovery of industrial waste will create alternative resources and promote costs efficiency (Jo Dewulf and Langenhove, 2005). Furthermore Jun, (1984) Hirayama et.al., (1987) and Gotoh, (1987) have identified the importance of industrial waste recovery in Japan; with proper recovery system implemented by the government and business mechanism has lead towards sustainable industrial waste management there.

Malaysia recognized the importance of industrial waste recovery. Through the Ministry of Natural Resources and the Environment and the Ministry of Housing and Local Government, waste recovery has been identified as an important activity. Awareness and education programs on waste recovery have been implemented with targeted audience of many levels of stakeholders, which include schools, business, industry and the community. Industrial waste recovery for the past decade has been identified as an emerging economic activity. Recovery of industrial solid wastes, such as plastic, steel, paper and glass has become an important support industry. This is in line with the increasing demand for limited natural resource, hence

waste recovery provides alternative resources and reduces dependency on natural resource such as oil for plastic. However the infrastructure for industrial waste recovery is not fully established. There are weaknesses in many sectors such as legislation, governance, technology, physical system, economic and human resource. These infrastructures are important to ensure that industrial waste recovery was done in sustainable manner and able to minimize impact to the environment and human health.

This study was conducted to determine the infrastructure needed towards ensuring sustainable industrial waste recovery in Malaysia. Important infrastructures for physical system such as transportation, landfill, treatment plant, handling facilities and transfer station were determined. Other than physical system, the supporting infrastructure analyze in this study were governance system, technology and economy

Methodology

This research was conducted through an assessment of secondary data derived from government agencies, business and industries. A survey was conducted with senior officers or managers of government agencies, business and industries as the respondents. Data from the survey and the secondary data were analyzed with SWOT analysis. Identification and analysis of important variables of each infrastructure sectors namely the physical, governance and the economic infrastructures were also conducted using SWOT analysis (Houban et. al. 1999). To understand the current status and trends of industrial waste generation and recovery, statistic analysis was conducted. The data collected from secondary source were analysed using simple percentage analysis (Rai and Lal, 2000).

Industrial Waste Generation and Recovery Trends

A high volume of industrial waste generated daily demands good management system and effective support of infrastructure. With reducing number of landfill able to handle increasing wastes, there is need to recover wastes for other uses. Wastes such as plastic, steel, wood, glass and paper generated during manufacturing or packaging has been found having significant values. Industries now have developed a system and design to recover their products for recycling or reuse (ADEME, 1999). Depletion of natural resources has created critical problems to manufacturing industry. For example with increasing price of petroleum, the price of plastic pellet for manufacturing industry increases many folds. Hence recovery of plastic waste would help industry to obtain alternative resources, which is also able to reduce their manufacturing cost. High volume of waste generated by Malaysian industries for the past three decades provides enough supply of wastes for recovery purposes (Azni et.al., 2004). This will help to change the focus of end-of-pipe approach to sustainable use of wastes. Industrial wastes recovery also will minimize the vulnerability of ecosystems as it will reduce requirements for new landfills since most of the landfills in Malaysia have reach their maximum capacity.

The amount of solid waste generated in Malaysia increased from 16,200 tonnes per day in 2001 to 19,100 tonnes in 2005 or an average of 0.8 kilogram per capita per day (Malaysia, 2006). Nasir et. al. (1998) found that industries in Malaysia contribute 30% of solid wastes. Nasir et.al. (1998) also estimated that wastes generation increased at 4% annually. Hence it is estimated that the industrial solid wastes generation has increased from 7,721.58 ton/day in

1994 to 11,519.24 ton/day in 2005. Hazardous waste generation varied in the period 1994 to 2005. 417,413 metric tons of waste generated in 1994 and increased to 632,521 metric tons in 1996, later reduced to 548,916 metric tons in 2005 (DoE, 1995, 2003, 2006). The trend of hazardous wastes generation is shown in Figure 1.

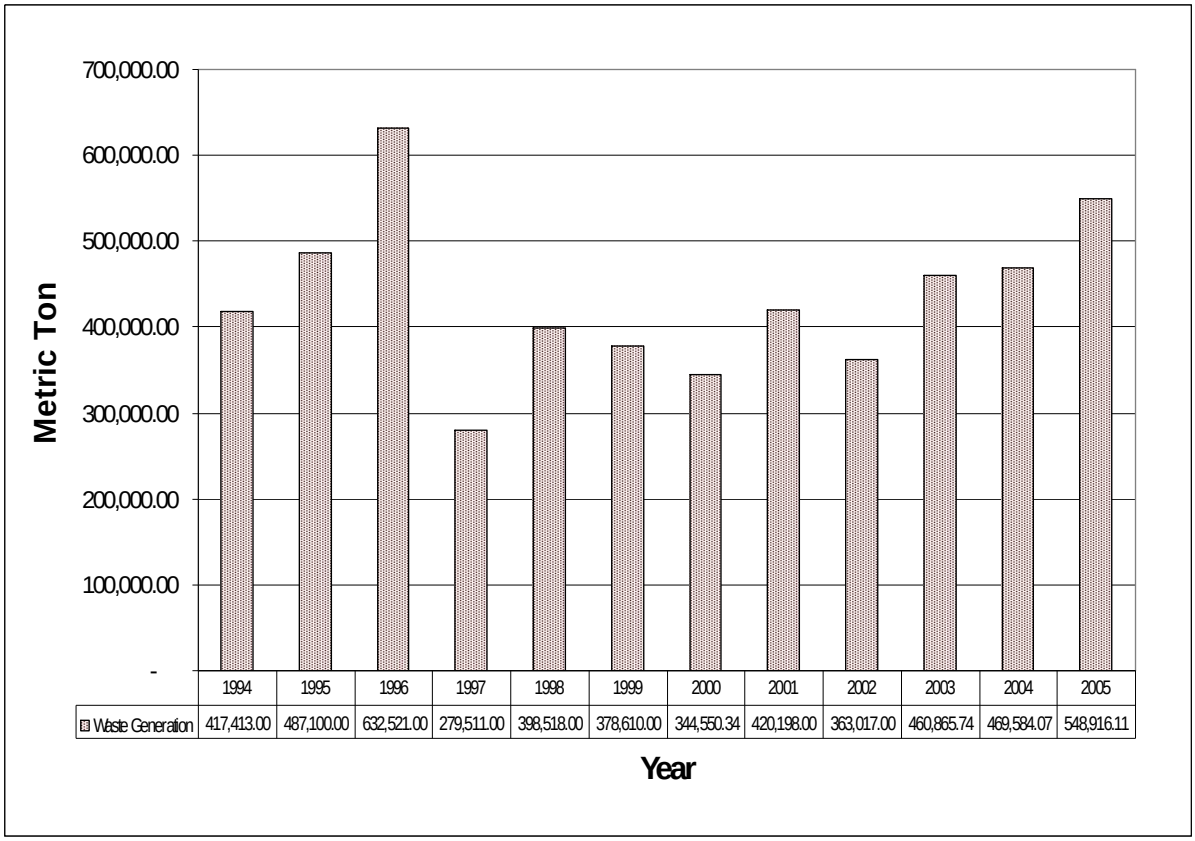


Figure 1: Toxic and Hazardous Waste Generation Malaysia 1994 - 2005 (DoE, 1995, 2003, 2006).

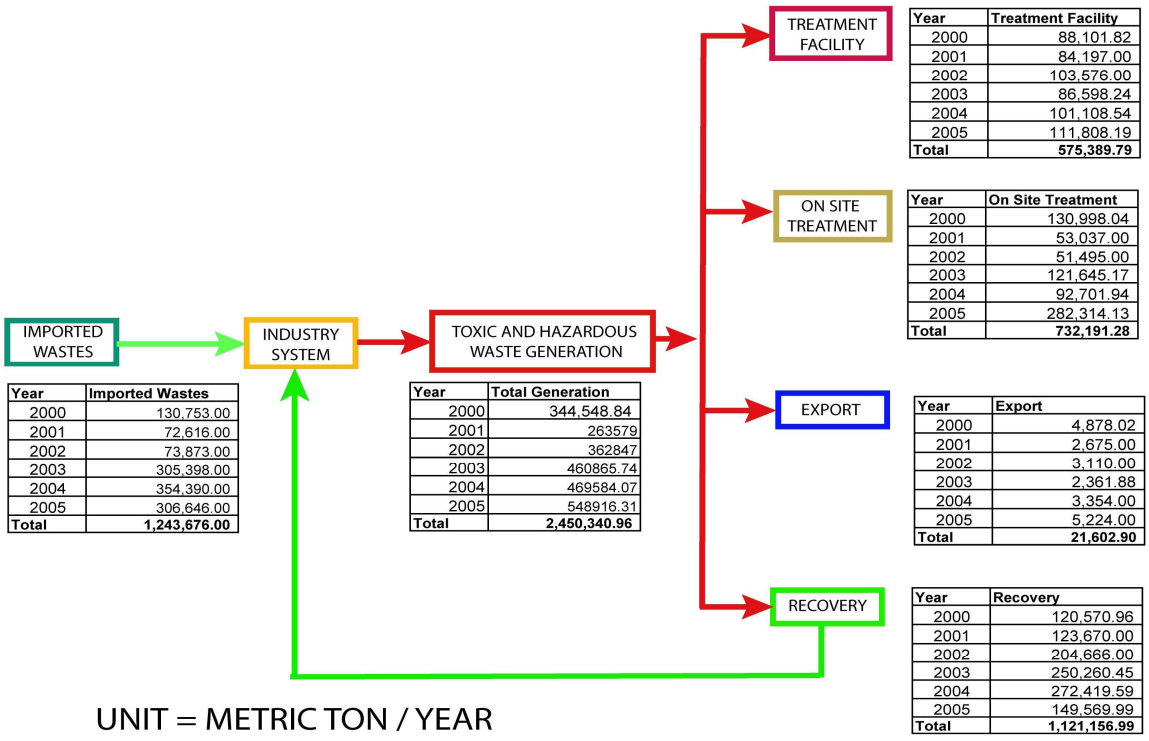
The trend of industrial wastes generation discussed above shows that, the amount is adequate for recovery. In 2004, there are 55 industrial solid wastes recyclers licensed by the Ministry of Housing and Local Government Malaysia. While for hazardous wastes, 122 recyclers were licensed by the Department of Environment Malaysia in 2006 to recover the wastes. Table 2 shows the types of industrial solid wastes recovered by the recyclers. Nasir et.al. (1998) estimated that 70% of total industrial solid wastes generated were recovered. Hence the amount of industrial solid wastes recovered is estimated at 5,405.1 ton/day in 1994, and increased to 8,063.47 ton/day in 2005.

Approximately 45.75% of hazardous wastes have been recovered from total wastes generation from 2000 to 2005 (Figure 2). Increasing trend of wastes recovery was observed, where recovery increased from 35% in 2000 to 58% in 2004. However the amount reduced to 27% in 2005. This data shows that a significant amount of hazardous wastes have been recovered, with many types of these wastes being traded in local and international market. The potential for these wastes to be recovered and for generation of economic benefit has a good future as demand for them is increasing (Malaysia, 2006). Between year 2000 to 2005, 1.12 million metric ton of industrial hazardous waste have been recovered. Using estimated value of RM 4,000 per metric ton, the estimated value of industrial hazardous waste recovery within this period is RM 4.48 billion. The total value of industrial hazardous waste recovery cycle

between year 2000 to 2005 in Malaysia which includes importation of this waste is estimated at RM 9.46 billion (3.4 million metric ton).

Table 2: Industrial solid waste recovered by recyclers

Type of Manufacturing Industry	Type of Waste
Electrical and Electronics	Paper, box, glass, scrap metal, wood, plastic, sludge, domestic waste, copper, aluminum, cast iron and steel
Mineral, concrete and ceramic	paper, carton box, glass, wood, plastic, concrete waste, metal and drum
Metal engineering	metal (copper, iron, aluminum) paper, carton box, glass, wood and plastic
Food and Beverages	paper, carton box and plastic
Pharmaceuticals	paper, carton box and glass
Paper, packaging and labeling	plastic and paper shreds
Chemicals	paper, carton box, glass, woods, plastic, metal (zinc, nickel, chromate, alodine)
Rubber	Paper, carton box, plastic, hydroxide metal sludge, vulcanized rubber waste, jute
Textiles	textile waste



Year	Imported Wastes
2000	130,753.00
2001	72,616.00
2002	73,873.00
2003	305,398.00
2004	354,390.00
2005	306,646.00
Total	1,243,676.00

Year	Total Generation
2000	344,548.84
2001	263579
2002	362847
2003	460865.74
2004	469584.07
2005	548916.31
Total	2,450,340.96

Year	Treatment Facility
2000	88,101.82
2001	84,197.00
2002	103,576.00
2003	86,598.24
2004	101,108.54
2005	111,808.19
Total	575,389.79

Year	On Site Treatment
2000	130,998.04
2001	53,037.00
2002	51,495.00
2003	121,645.17
2004	92,701.94
2005	282,314.13
Total	732,191.28

Year	Export
2000	4,878.02
2001	2,675.00
2002	3,110.00
2003	2,361.88
2004	3,354.00
2005	5,224.00
Total	21,602.90

Year	Recovery
2000	120,570.96
2001	123,670.00
2002	204,666.00
2003	250,260.45
2004	272,419.59
2005	149,569.99
Total	1,121,156.99

Figure 2: Fate of industrial hazardous waste in Malaysia from 2000 to 2005

Infrastructure for Sustainable Industrial Waste Recovery

Industrial waste recovery has been conducted with a small scale input, such as being done by the scavenger (Nasir et.al., 1998). However with increasing demand of waste for alternative resources, waste recovery is now being done by companies. There are now many companies that have been issues license for industrial wastes recovery. However the existing practice was not supported with a good infrastructure to ensure that the activity is sustainable and environmentally friendly. The infrastructures required for sustainability could be divided into three sectors; the governance, the physical and the economic infrastructures.

The governance infrastructure plays an important role, as it provides the infrastructure for good management to minimize impacts on the environment and human health. Governance infrastructure for managing industrial waste recovery in Malaysia has provided a good foundation that is based on legislation. Table 3 shows key legislations and stakeholders involved in governing industrial waste recovery. The legislation for industrial wastes recovery in Malaysia focuses on two types of wastes; industrial solid wastes and industrial hazardous wastes.

Table 3: Legislation and stakeholders for industrial waste management and recovery in Malaysia

Agency	Legislations	Scope
Ministry of Natural Resources and Environment Department of Environment (DoE) Enforcement measures are shared with: Ministry of Trade and Industry Ministry of Agriculture with the support of Department of Agriculture Department of Fisheries	Environmental Quality Act 1974 (from this Act there are at least 5 Regulations that can be linked directly and nine indirectly)	Prevention, abatement and control of pollution Regulation to recover wastes and resources under EQA 1974 Part IV Regulations provided for industrial activities such as: ● Crude Palm Oil ● Raw Natural Rubber ● Scheduled Wastes, Treatment and Disposal Facilities ● Marine Pollution ● Use of controlled substances in soap, synthetic and other cleaning agents
Ministry of Housing and Local Government Department of National Solid Waste Management Department of Local Government	Solid Waste Management and Public Cleansing 2007. Local Government Act 1976 and local governments by laws. Street, Drainage and Building Act, 1974 and Town and Country Planning Act.	The National Strategic Plan for Solid Waste Management emphasizes waste recovery.

Ministry of Agriculture	Pesticides Act 1974	Control of pesticides for use, sale and import of, and production
Ministry of Home Affairs Department of Royal Customs and Excise	Control of Supplies Act 1961 Environmental Quality Act 1974 Pesticides Act 1974	Control and rationing of controlled articles / items Control of import and export
Ministry of Human Resource Development	Occupational Safety and Health	Health, safety and welfare of workers

The key stakeholders in managing industrial solid waste generated by industry were Ministry of Housing and Local Governments and its two departments, the Department of National Solid Waste Management and the Department of Local Government, governing the law. The solid wastes contractors companies, industry and solid wastes recyclers became key stakeholders governed by the law (Table 3). Recovery of industrial wastes has become an important supporting activity for manufacturing industries. Wastes recovered and recycled by factories in Malaysia turn into basic materials to produce other products. Paper and aluminum cans recycling has been achieving good responses and found to be successful in Malaysia. Other materials recycling scheme is in the process of research and development, and hope that it will start off soon. Indeed, industrial solid waste recovery through recycling program has been the main agenda in Malaysia. The National Strategic Plan for Solid Waste Management (Strategic Plan) 2007 prioritizes reduction, reuse, recovery and recycling of waste as well as greater use of environment friendly materials (Malaysia, 2006).

Legislation for recovery of hazardous wastes in Malaysia was done through Environmental Quality Act (EQA) 1974. The Local Government Act, 1976 and the Customs and Excise Act are two laws that support the EQA 1974 enforcement. The EQA 1974 interpret hazardous wastes as scheduled waste and refer to 58 categories and 107 types of wastes. Recovery of scheduled wastes was given priority in 2005, when an amendment was made under Part IV of EQA 1974. The key stakeholders involved were Department of Environment (DoE) and supported by the Department of National Solid Waste Management.

Legislation enforcement will require good governance infrastructure for effective enforcement. The involvement of many stakeholders is required to ensure governance effectiveness. This includes understanding the boundaries of responsibility and actions for each enforcement agency. Synchronization of acts and regulations by relevant agencies is necessary. Strong institutional support has been identified as a critical factor in the future of legislation enforcement (Sham, 1997). Hence institutional structure is important for effective governance infrastructure and to achieve good management system as well as to establish other supporting systems.

The physical infrastructure is also important for recovery activities by the wastes generator, the transporter and the recycler. The existing infrastructures available which support industrial wastes recovery are transportation system, recovery centres, treatment centres and landfill. Industrial solid wastes recovery in Malaysia has been done with lack of environmental concern. Recycling facilities available run as a junk yard. However, there are companies with better facilities which prioritize modern and clean process, but the number is small. In comparison, hazardous waste recovery facilities and its collection system are monitored by

the Department of Environment (DoE). Hazardous wastes recovery is controlled and done in environmentally friendly approach. The critical issues in the physical infrastructure identified are supports system for the collection of wastes, modern and environment friendly recycling facilities and human resources. Technology development and application is required to improve the physical infrastructure. The most important technology is to enhance recovery facilities capability to recycle more types of industrial waste, especially the hazardous wastes. This technology helps the industrial wastes recovery ability to supply more alternative resources, and helps to reduce dependency on natural resources.

The financial and economic infrastructure includes mechanisms and tools to ensure that the efficient wastes recovery activities. The financial and economic infrastructure are important to ensure that industrial wastes recovery is economically viable, and that it recycles virtually all of the materials use, emitting only micro amounts of waste and pollutants, while providing increasingly high quality services. The mechanisms and tools should be placed into policy options for resource conservation thus facilitating the sustainability of affordable environmental investment through waste management and cleaner production (Marans and Lee, 1993; Kjaerheim, 2005). In ensuring effective mechanisms for financial arrangement it is important that the strategy for the mechanisms be institutionalized within the management regime of key stakeholders. The mechanisms should not be introduced or used as a voluntary action especially by the business and industrial players. Hence financial and economic tools will include financial support, insurance services, market system and trade promotion (Table 4).

Table 4: Financial or economic tools for industrial waste recovery in Malaysia

Economic Tools	**Financial Tools**
▪ Market incentives ▪ Labour levy ▪ Tax reduction for cleaner production ▪ "Polluters pay" principle ▪ Market promotion for environmental friendly products	▪ Deposit and refunds system ▪ Rebate mechanisms for purchasing cleaner technology or equipment ▪ Low insurance premium for environmental friendly industry and products promoting waste recovery ▪ Finance or loans to produce cleaner products ▪ Finance or loan for waste recovery and recycling of waste as a resource

Conclusion

Good infrastructures in place ensure sustainable industrial waste recovery. Why? Because managing these wastes as resources through wastes recovery activity will help to minimize the impact of waste to environment and create alternative source of resources. Waste recovery activity also provides jobs and business opportunities. The set back of enhancing or establishing infrastructure discussed above require full commitment of all key stakeholders. Political will and business commitment will promote establishment and effectiveness of infrastructure especially the governance, the economy and technology development. These infrastructures should be put in place to achieve sustainable industrial wastes recovery in Malaysia, helping to minimize negative impacts to the environment and human health. The requirement for recovery of industrial wastes as a resource is an important activity especially for resource efficiency, and contributes towards achieving sustainable industrial development

which has been highlighted in the National Policy on the Environment 2002 and in the statement of the Eight Malaysia Plan, (Malaysia, 2001).

Reference

ADEME (French Agency for Environment and Energy Management), 1999. Product Design and Environment. ADEME, Paris.

Azni Idris, Bulent Inanc and Mohd Nasir Hasan, 2004. Overview of Waste Disposal and Landfills/Dumps in Asian Countries. *Journal of Material Cycles and Waste Management.* Volume 6, No.2, pp 104-110.

Department of Environment Malaysia (DoE), 1995. Malaysia Environmental Quality Report 1994. Kuala Lumpur.

Department of Environment Malaysia (DoE), 2003. *Malaysia Environmental Quality Report 2002*. Putrajaya.

Department of Environment Malaysia (DoE), 2006. *Malaysia Environmental Quality Report* 2005. Putrajaya.

Erkman, S., 2002. The Recent History of Industrial Ecology in Ayres, R.U. and Ayres, L.W (eds) *A handbook of Industrial Ecology*. Edward Elgar, Cheltenham, UK.

Gotoh, S., 1987. Waste Management and Recycling Trend in Japan. Resources and Conservation. Volume 14, pp 15-28.

Hirayama, N., Gotoh, S. and Yajima, T., 1987. Recovery of Mercury and Other Metals From Used Battery Cells – The CJC Demonstration Plant in Hokkaido Japan. Conservation and Recycling, Volume 10, Issue 4, pp 237 – 241.

Houban, G., Lenie, K. and Vanhoof, K., 1999. A Knowledge-based SWOT-analysis system as an instrument for strategic planning in small and medium enterprises. In *Decision Support Systems*, 26, pp 125 – 135. Elsevier.

Jo Dewulf and Herman Van Langenhove, 2005. Integrating industrial ecology principles into a set of environmental sustainability indicators for technology assessment. *Resources, Conservation and Recycling*, Volume 43, Issue 4, Pages 419-432

Jun Ui, 1984. An Overview on Solid Waste and Hazardous Waste in Japan. Conservation and Recycling. Volume 7, Issues 2-4, pp 67-71.

Kjaerheim, G.,2005. Cleaner production and sustainability. *Journal of Cleaner Production*, Volume 13, Issue 4, March 2005, Pages 329-339.

Malaysia, 2001. *Eight Malaysia Plan 2001 – 2005*. Economic Planning Unit, Prime Ministers Department, Putrajaya, Malaysia.

Malaysia, 2006. Ninth Malaysia Plan 2006 – 2010. Economic Planning Unit, Prime Ministers

Department, Putrajaya, Malaysia.

Marans, R.W. and Lee, Y.J., 1993. Linking recycling behavior to waste management planning: A case study of office workers in Taiwan. *Landscape and Urban Planning*, Volume 26, Issues 1-4, October 1993, Pages 203-214

Nasir, M.H, Kamil, M.Y, Azmin, S.N and Rakmi, A.R., 1998. Issues and Problems of Solid Waste Management Pages 179 – 225 in Mohd Nordin Hasan et.al.(Eds.) *National Review on Environmental Quality Management in Malaysia; Towards the Next Two Decades.* Institute for Environment and Development, Universiti Kebangsaan Malaysia, Bangi

Pongrácz, E and Pohjola, V.J., 2004. Re-defining waste, the concept of ownership and the role of waste management. *Resources, Conservation and Recycling.* No. 40 (2004), pp 141–153.

Rai, L.P. and Lal., K., 2000. Indicators of the information revolution. *Technology in Society*. Volume 22, Issue 2, Pp 221-235.

Recycling Point Dot Com, 2003. http://www.recyclingpoint.com.sg/Articles/ access on 3rd December 2003.

Sham, S., (1997). *Environmental Quality Act 1974: Then and Now.* Institute for Environment and Development (LESTARI), UKM, Bangi.

The Star, 2003. *RM 12 Million Disposal Costs Shock Selangor Exco*, 4th December 2003.