

## Ecosystem Approach for Sustainable Industrial Hazardous Waste Management in Malaysia

<sup>1</sup>Ahmad Fariz Mohamed, <sup>1</sup>Muhammad Awang, <sup>2</sup>M. Nasir Hassan and <sup>3</sup>Abu Bakar Jaafar

<sup>1</sup>Institute for Environment and Development (LESTARI),

UKM, 43600, Bangi, Selangor D.E., Malaysia

<sup>2</sup>Department of Environmental Management, Faculty of Environmental Studies,

UPM, 43400 Serdang, Selangor D.E., Malaysia

<sup>3</sup>Enviro-Lift Services Sdn Bhd, Shah Alam, Selangor D.E., Malaysia

**Abstract:** Manufacturing industries play a vital role for the Malaysian economic growth for the past 4 decades. However, industrial activities generated large amount of hazardous wastes which have detrimental impacts on the environment and the society. In 2002, industries in Malaysia generated about 363,017 metric tons of hazardous waste. The number of factories generating hazardous waste increased from 960 in 1994 to 4,079 in 2002. The current management system for these wastes emphasizes on the end-of-pipe approach which prioritize the use of final treatment and disposal system. This approach has created many problems including illegal disposals and many cases of pollution to the environment. Acknowledging the problems, alternative approach is needed to achieve sustainable industrial hazardous wastes management. One of the possibilities is to use the ecosystem approach. The ecosystem approach promotes integrated and holistic approach in managing industrial hazardous wastes. The approach emphasizes the creation of industrial ecosystem, where resources efficiency is the priority and wastes become important resources. This is in line with the Malaysia policy emphasizing implementation of industrial symbiosis concept for sustainable industrial development.

**Key words:** Hazardous waste, recovery, ecosystem, sustainability

### INTRODUCTION

Manufacturing industry is one of the key sectors driving Malaysia economic growth. During the period of 1985-1995, manufacturing output expanded significantly, surpassing most of the targets set. This sector has performed very well and in 1996 it has contributed RM 45.2 billion to the Gross Domestic Product (GDP) about 34.6% from overall GDP, with 13.3% growth over the previous year value (Fariz *et al.*, 2004). The performance of manufacturing industry has been geared up and its growth increased 13.5% in year 1999 and 21% in year 2000. This has lead to GDP contribution of 33.4% in year 2000 (Fariz *et al.*, 2004). Despite good performance in contributing to Malaysian economic growth, manufacturing industries also generate huge amount of wastes. Industrial hazardous waste for example has become environmental and human health issues which need special attention by the waste generators and government agencies. The existing management approach was found unsustainable since, handling of hazardous

wastes prioritize treatment and disposed off in landfill, hence, this waste became a non-value resource. There is a need to change this practice through application of sustainable approach. One of the approaches identified was ecosystem approach. Ecosystem approach emphasize the need for industry to ensure resource efficiency and wastes recovery for alternative resources.

### MATERIALS AND METHODS

This research has been conducted through assessment of secondary data derived from government agencies, business and industries. Source of data from period of 1994-2002 were collected from annual reports, official statistic data and loose sheet data. The secondary data were analyzed using statistical analysis to shows trend of wastes generation and wastes recovery. Policy and management analysis were conducted using SWOT analysis (Houban *et al.*, 1999), to determine the current management system weakness and applicability. This method also helps to determine suitable approach for industrial hazardous waste management system.

**RESULTS AND DISCUSSION**

Industrial hazardous wastes management in Malaysia are done through specific policy, legislative and institutional structure. The National Policy on the Environment established in 2002 support with existing legislative act, the Environmental Quality Act (EQA) 1974, the Local Government Act, 1976 and the Customs and Excise Act play a major role in helping better manage industrial toxic and hazardous waste. Table 1 shows the legislation and stakeholders involved in managing industrial hazardous waste.

The EQA 1974 interpret hazardous wastes as scheduled waste and refer to 58 categories and 107 types of wastes listed in the first schedule and in the 4th scheduled. While, a mix between any 58 types of wastes listed also deem to have potential negative consequences in the regulation. However, hazardous wastes definition goes beyond of EQA 1974 definition of this waste. Therefore, scheduled wastes stated in the environmental quality (Scheduled Wastes) Regulation 1989 will be also referred to as hazardous wastes in this study. Additional to EQA 1974, there are other specific acts, which have equal responsibility, these includes Poisons Ordinance, Dangerous Drugs Ordinance, Explosive Ordinance, Occupational Safety and Health Act, Radioactive Substances Ordinance and Pesticides Act (Jamaluddin, 1993). These legislative are under responsibility of other agencies with different responsibilities, with at least 4 different agencies and legislations that deal with aspects of hazardous wastes management (Table 1).

**Industrial hazardous waste management issues in Malaysia:** Hazardous wastes created many issues and problem mainly in the phase of it's generation, treatment

and disposals. Currently in Malaysia there is no specific policy on industrial hazardous wastes. The absence of clear policy to improve the environmental performance in managing industrial hazardous wastes has become the main stumbling block. The EQA 1974 focus more on treatment and disposals of hazardous wastes and it did not deal with the whole cycle of hazardous wastes management. Basically there are many laws involved in the life cycle of products with reference to hazardous wastes as shown in Table 2. However, these laws are not being integrated in view of hazardous wastes management perspective.

Three fold of problems identified in regulating industrial hazardous wastes where law is concerned. Firstly, for lack of listing and identification, not all of these wastes are regulated. Secondly, although, hazardous wastes are regulated by one specific agency and one particular legislation, there exists overlaps and gray areas that can be attributed to the division of legislative and administrative powers so designated by the Federal Constitution of 1957 (Mokhtar *et al.*, 2002). However, as for the industry is concerned it falls under the purview of the Federal Government and where industrial hazardous wastes is concerned, it can be both the Federal and State government particularly when it is seen from the management perspective, from discharge, collection, storage, transport, disposal, clean-up and treatment. Thirdly, there is no one objective or direction set in clear terms particularly as to how the law should be used to facilitate effective industrial hazardous waste management. This perhaps can be attributed to the fact that industrialization gained speed in the late 1980's and has since, rapidly grown to include all spectrum of the types of industries.

Table 1: List of agencies, legislations and scope in hazardous waste management in Malaysia

Agency	Legislations	Scope
Ministry of natural resource and environment  Department of Environment (DoE) Enforcement measures are shared with: Ministry of International Trade And industry  Ministry of Agriculture and Agro-base Industry with the support of Department of Agriculture and Department of Fisheries Ministry of Agriculture and Agro-base Industry	Environmental quality act 1974 (from this Act there are at least there are at least 5 regulations that can be linked directly and 9 regulations indirectly)	Prevention, abatement and control of pollution 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 Home Affairs Department of Royal Customs and Excise	Pesticides Act 1974	Control of pesticides for use, sale and import of and production
Ministry of Human Resource Development	Control of Supplies Act 1961 Environmental Quality Act 1974 Pesticides Act 1974	Control and rationing of controlled articles / items Control of import and export Health, safety and welfare of workers
	Occupational Safety and Health	

Source: Fariz *et al.* (2004)

The need for strong policy and legislative structure for managing hazardous wastes waste is critical for Malaysia since, the trends of the generation is increasing. Hazardous waste generation varied from 417,413 metric tons in 1994, increased to 632,521 in 1996 than reduce to 363,017 metric tons in 2002 as shown in Fig. 1 (DoE, 2000, 2004). Number of factories generated hazardous waste increased from 960 factories in 1994-4,079 in 2002. Hazardous wastes export and import trends are shown in Fig. 2 (DoE, 2004). This data shows that there is a significant value place on hazardous wastes for local and foreign market.

Generation of wastes have a strong correlation with resource utilization in manufacturing process. The amount of wastes generated increased significantly with the volume of resources used, such as minerals or metals. Manahan (2000) stated that reducing the amount of resources and increasing the efficiency of the production system will reduce waste generation in the processing system. Measures need to be taken to give more attention to aspects of production where waste minimization and impact could be lessened as well as looking at how to increase value of waste produced from manufacturing and utilization of products by other industries and consumers. These approaches which blend together with technological advancement will lead to industrial waste reduction and made products more environmental friendly (Steven and Robert, 2000).

It is important to have good hazardous waste management emphasize in waste minimization and reduce

Table 2: Laws related to selected components in the life cycle of industrial hazardous wastes

Life cycle components	Legislations related
Listing, classification or identification generation	Environmental Quality Act 1974
Transport	Environmental Quality Act 1974
	Factories and Machinery Act 1967
	Pesticides Act 1974
	Poisons Act 1952
Storage	Occupational Safety and Health Act 1994
	Occupational Safety and Health Act 1994
	Occupational Safety and Health Act 1994
Disposal	Factories and Machinery Act 1967
	Environmental Quality Act 1974
	Occupational Safety and Health Act 1994
	Town and Country Planning Act 1976 (for sites-zoning)

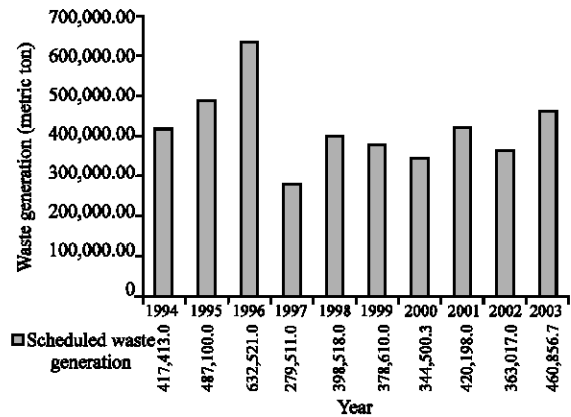


Fig. 1: Schedule waste generation in Malaysia from 1994-2002. Source: Department of Environment (2004)

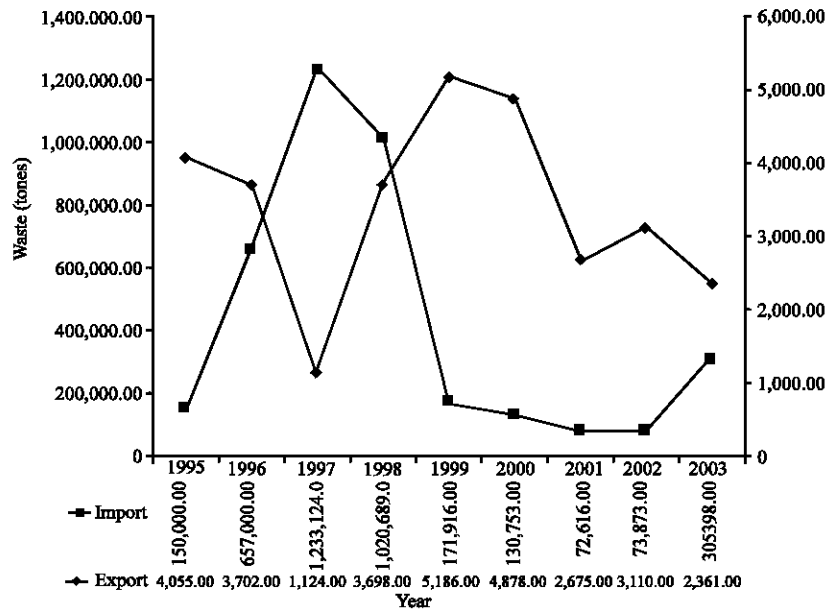


Fig. 2: Import and export of scheduled waste Malaysia from 1996-2003. Source: Department of Environment (2004)



Fig. 3: Linear materials flow in type I ecology (Allenby, 1992)

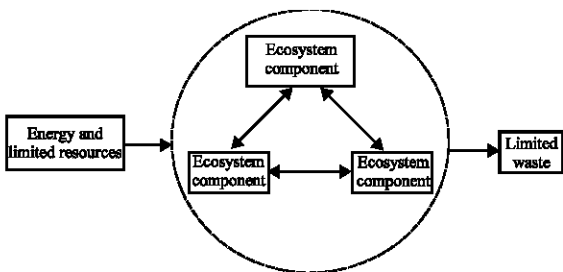


Fig. 4: Quasi-cyclic materials flows in type II ecology (Allenby, 1992)

amount of wastes send to open dumpsite or landfill. With complex characteristics of these wastes, it will have diverse impacts on the environment and human health. Good hazardous waste management, should includes approaches towards minimizing waste generation, increase efficiency of resources use, use of cleaner technology and produce cleaner product. A better approach where the hazardous wastes transform into an alternative resources need to be determined. Such approach includes ecosystem approach, which able to determine all the mechanisms needed to assure that the industrial activities and generation of hazardous wastes will not deteriorate the environment and human health.

**Ecosystem as an approach for sustainable industrial hazardous waste management in Malaysia:** The term ecosystem suggests that models of non-human biological systems and their interactions in nature are instructive for industrial systems that are designed and operated. The industrial ecosystem would function as an analogue of biological ecosystems. The biological model is attractive due to the manner in which nature developed its constituents to live off the bodies and wastes of one another. In such a system the consumption of energy and materials is optimized, waste generation is minimized and the effluents or waste generated of one process from consumer products serve as the raw material for another process. Ecosystem work on premise in promoting modern industrial economy mimic the cycling of materials of an ecosystems, where all materials are said to be reused with great efficiency. Ecosystem approach takes a systems view and shifting from end-of pipe pollution control methods towards a more holistic view of industrial

production and environmental protection. Ecosystem approach emphasize industry to change from linear materials flows (Fig. 3) to quasi-cyclic materials flows (Fig. 4) to increase efficiency and recovery of resources (Allenby, 1992).

The quasi-cyclic materials flows promote dynamics balance within and between system components. It increases efficiency as the flows of resources into the industrial system are large in quantity while, the flows out of wastes generated are small. It takes systems view of industry in developing strategies to facilitate more efficient use of material and energy resources and ensure cycle of resources within the ecosystem and to reduce the release of hazardous as well as non-hazardous wastes to the environment.

Potential of ecosystem approach applied for industrial hazardous waste management in Malaysia is visible. Recovery of hazardous wastes as valuable materials within an industrial ecosystem in Malaysia as one of the key activity in ecosystem approach has been implemented. From 1997-2003 about 2,719, 890.00 metrics tons of hazardous wastes has been recycled or reuse in Malaysia (DoE, 2003). Moreover, many of these wastes were being exported and imported as resources for industrial use (Fig. 2). To ensure effective cycle of industrial hazardous wastes, ecosystem approach will provide mechanisms, tools and network system to assure that the recovery of these wastes were conducted in sustainable manner. The challenge now is to establish the industrial ecosystem, creating all the key components and identifying mechanisms and tools suitable for Malaysian industries need.

**Support needed to establish ecosystem approach for sustainable industrial hazardous waste management in Malaysia:** Establishing ecosystem approach for sustainable industrial hazardous wastes management in Malaysia will need strong policy and support from all key stakeholders especially from the business and industry. In term of policy, the goals of National Policy on the Environment 2002 and a basic concept of ecosystem has been highlighted through a statement in Eight Malaysia Plan (RMK8), emphasizing implementation of industrial symbiosis concept for industrial development. Important concept of resource recovery has been established in Malaysia through program such as recycle, reduce and reuse (3R), cleaner production, bio-fuel or renewable energy and certification of ISO 14000 standards. Industries in Malaysia will benefits, as these will help their global market competitiveness and enhance Malaysian industries image, as well as promoting Malaysia as one of the industrial nation who support sustainable development.

## CONCLUSION

Industrial hazardous waste management has become a critical environmental issue in Malaysia. There are many factors need to be considered to develop a sustainable industrial hazardous waste management system. Ecosystem approach helps to assure good management and reduce environmental and human health impact. Resource recovery within this approach, will help industry to reduce its operational costs. Industries and business will also able to get alternative resources and reduce dependency to natural resources, where, it helps to prolong natural resources supply. Moreover, industries and business are able to comply with local and foreign country environmental requirements. Government agencies will benefits by achieving minimum environmental issues and other unnecessary monitoring and enforcement research. However, the challenge was to change the mind set of stakeholders and to establish the industrial ecosystem and its habitat to promote integration and cycle of materials through resource recovery. Ecosystem approach would be the future of integration approach since, the Malaysian government has acknowledge the importance of this approach through implementation of industrial symbiosis concept for industrial development in Malaysia. Therefore, ecosystem approach for industrial hazardous waste management will be the forward looking approach to assure sustainable industrial development in Malaysia.

## REFERENCES

- Allenby, Braden R., 1992. Industrial Ecology: The materials scientist in an environmentally constrained world. *Material Res. Soc. (MRS) Bull.*, 17 (3): 46-51. [http://www.mrs.org/s\\_mrs/sec.asp?CID=9779&DID=199318](http://www.mrs.org/s_mrs/sec.asp?CID=9779&DID=199318).
- Department of Environment Malaysia (DoE), 2000. Malaysia Environmental Quality Report, 1999. Government of Malaysia Printers. Kuala Lumpur. ISSN: 0127-6433.
- Department of Environment Malaysia (DoE), 2004. Malaysia Environmental Quality Report, 2003. Government of Malaysia Printers. Putrajaya. ISSN: 0127-6433.
- Fariz, A.M., M. Awang, M.N. Hasan and A.B. Jaafar, 2004. Managing Industrial Toxic and Hazardous Waste in Malaysia. In: Proc. 2nd Bangi World Conf. Environmental Management: Facing Changing Conditions 22nd-23rd October 2004. Centre of Graduate Studies, UKM, Bangi. ISBN: 983-2446-64-3.
- Houban, G., K. Lenie and K. Vanhoof, 1999. A Knowledge-based SWOT-analysis system as an instrument for strategic planning in small and medium enterprises. In: *Decision Support Syst.*, 26 (2): 125-135. Elsevier B.V. DOI: 10.1016/S0167-9236(99)00024-X.
- Jamaluddin, J., 1993. Issues on environmental Management through legislative measures in Malaysia. *Akademika: J. Soc. Sci. Humanit. UKM, Bangi.*, 42 (43): 181-204. ISSN: 0126-5008.
- Manahan, S.E., 2000. *Fundamental of Environmental Chemistry*. 2nd Edn. Lewis Publishers, Boca Raton, USA, pp: 664-665. ISBN-10: 156670491X. ISBN-13: 978-1566704915.
- M. Mokhtar, S. Aziz, A.G. Aziz and A.F. Mohamed, 2002. Approaches to Managing and Regulating Hazardous and Toxic Substances. Round LESTARI Table Dialouges Series No. 9. LESTARI, UKM, Bangi. ISBN: 983-9444-31-X.
- Steven, W.P. and R.B. Gibson, 2000. Pushing the Revolution. *Alternative J.*, 26 (1): 20-32. Gale Group. [http://alternativesjournal.ca/index.php?option=com\\_content&task=view&id=629](http://alternativesjournal.ca/index.php?option=com_content&task=view&id=629).