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Economic Instruments for Managing Industrial Waste in Malaysia

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ABSTRACT

Rapid development process of manufacturing industry in Malaysia has resulted to increasing amount of industrial and hazardous waste generation. It is recognized that industrialization has economic, environmental and social trade-offs. Where there are trade-offs between environmental preservation and economic development, several alternatives are employed to mitigate those harmful effects. Such actions are required under the existing and currently reviewed environmental laws and regulations and proposed economic incentives. In the past Malaysia emphasized the economic benefits of development. Now there is an emphasis on the environment. The Government of Malaysia should consider that like many developed countries, the use of appropriate economic tools and incentives in order to achieve a resilient developed country. These instruments are needed to encourage environmentally responsible decision-making by investors, consumers and other economic actors.

ABSTRAK

Proses pembangunan industri pembuatan yang begitu pesat di Malaysia telah menyebabkan peningkatan penghasilan bahan buangan industri dan berbahaya. Sememangnya diketahui bahawa perindustrian mempunyai keseimbangan daripada segi ekonomi, alam sekitar dan sosial. Apabila wujud keseimbangan diantara pengekalan alam sekitar dengan pembangunan ekonomi, beberapa alternatif diambil untuk menangani akibat buruknya. Langkah sedemikian adalah diperlukan di bawah undang-undang dan peraturan alam sekitar sedia ada dan yang sedang dikaji semula serta galakan ekonomi yang dicadangkan. Pada masa lalu Malaysia menekankan kepada keuntungan ekonomi sesuatu pembangunan. Kini telah wujud penekanan terhadap alam sekitar. Seperti banyak negara membangun yang lain, Malaysia sepatutnya memikirkan tentang penggunaan alat ekonomi dan galakan untuk menjadi sebuah negara maju yang amat bingkas. Alat-alat tersebut diperlukan untuk menggalakkan pembuatan keputusan yang bertanggung jawab alam sekitar oleh pelabur, pengguna dan peserta ekonomi lainnya.

INTRODUCTION

Malaysia is aiming to be an industrialized country by the year 2020. To achieve this vision, the government has identified industrial sector as the key sector. Therefore, manufacturing industry plays a vital role in enhancing Malaysian economic growth. This sector has performed very well, and in 1996, it has contributed RM 45.2 billion to the GDP, about 34.6 percent from overall GDP, with 13.3 percent growth over the previous year value (Malaysia 1996, 1997). However, during the economic recession from 1997 to 1998, manufacturing growth reduced by 13.4 percent. The performance of manufacturing industry has been geared up and its growth increased 13.5 percent in 1999 and 21 percent in 2000. This has lead to GDP contribution of 33.4 percent in year 2000 (Malaysia 2001). Manufacturing industry will continue as a key sector in economic growth for Malaysia with target growth of 8.9 percent per annum from 2001 to 2005, and expected to contribute 35.8 percent to GDP by 2005 (Malaysia 2001).

Rapid development process of the manufacturing industry in Malaysia has resulted to increasing amount of industrial and hazardous waste generation volume annually.

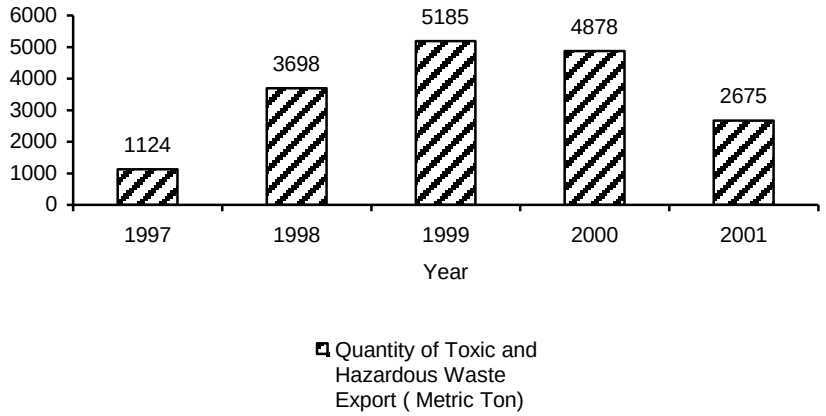

Figure 1. Quantity of scheduled waste exported from 1997 to 2001
Source: Department of Environment 2001a

Toxic and hazardous waste generation increased from 378,610.74 metric ton in 1999 to 420,198 metric ton in 2001 as shown in Figure 1 (Department of Environment 1999, 2001a). Manufacturing industry in

Malaysia also export and import toxic and hazardous waste, where in 2001 Malaysian industries exported 2,675 metric tons and imported 69,942 metric ton of scheduled waste (Department of Environment 2001b). A study conducted by Nasir et al. (1998), found that industries in Malaysia produce about 59.39 metric tons of industrial solid wastes per day with increment rate of 4 percent per year. The Department of Environment Malaysia has conducted enforcement visits to 3,314 manufacturing industries in 2001, and recorded that only 79 percent of factories comply with the relevant law.

The objective of this study is to discuss about the economic instruments such as, property rights, market creation, fiscal instruments, charge systems, financial instruments, liability instruments, performance bonds and deposit refund systems and its impact on industrial waste management in Malaysia.

INDUSTRIAL WASTE MANAGEMENT IN MALAYSIA

Industrial waste management in Malaysia has become an important activity that goes along with industrialization process. It falls under the jurisdiction of Local Government Act, 1976, Street, Drainage and Building Act, 1974 and Town and Country Planning Act, 1976. Specific definition of industrial solid waste is not available under Local Government Act, 1976. However under the Local Government by-laws, Rahmah (2001) stated that solid wastes were categorized as follows:

- Waste materials include any valuable or non-valuable by-products, reject or spoilt products produced in manufacturing process.
- Trade waste includes any waste materials generated by trade activity.
- Industrial waste includes any waste materials generated from industrial activity.
- Park waste includes leaves, grass, tree branches or soil from parks or from house building compound or from land.
- Household waste includes all types of waste generated from household.

Solid wastes generated by industries thus fall under these categories hence the Local Government Act, 1976 and local governments by-laws were able to manage industrial solid wastes.

Similar to industrial solid waste management, managing industrial toxic and hazardous wastes were also done through specific legislative structure. At the moment the Environmental Quality Act (EQA), 1974,

the Local Government Act, 1976 and the Customs and Excise Act are the three laws that are playing a major role in helping better management of industrial toxic and hazardous waste. The Environmental Quality Act, 1974 specifically addresses the toxic and hazardous wastes under its subsidiary legislation as follows:

- Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations, 1977
- Environmental Quality (Prescribed Premises) (Raw Natural Rubber) Regulations, 1978.
- Environmental Quality (Sewage and Industrial Effluent) Regulations, 1979.
- Environmental Quality (Scheduled Wastes), Regulations, 1989
- Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposals Facilities) Order 1989.

These regulations fall under the jurisdiction of the Department of Environment. Specifically toxic and hazardous waste are directly managed under the Environmental Quality (Scheduled Wastes), Regulations, 1989. Others have a significant role in managing toxic and hazardous waste through its activities and characteristics.

The current practice in managing industrial wastes in Malaysia was found applying "end of pipe" approach. Wastes generated by the industries were disposed in the open dumpsite or landfill. There are cases where small volume of industrial wastes were disposed by burning in soil within factory compound or dumped into bushes, plantation or stored in warehouses. Little emphasis has been given by industries to recover their wastes because of the low values being given by current market system. Moreover the Environmental Quality (Scheduled Wastes) Regulations, 1989 did not promote recovery or recycling of toxic and hazardous waste. The law only stated how to manage the wastes at the end of its production and consumption. However, issues pertaining to industrial toxic and hazardous wastes management are related to many factors.

ECONOMIC POLICY AND INSTRUMENTS

It is well recognized that industrialization has economic, environmental and social trade-offs. Where there must be trade-offs between environmental preservation and economic development, several alternatives are employed to mitigate harmful effects. Such actions are required under the existing and currently proposed environmental laws, regulations and economic incentives.

In the past, Malaysia emphasized the economic benefits of development, now there is also a major emphasis on the environment.

The Government in Malaysia should recognize that guiding the economy towards sustainable development would require the use of appropriate economic tools and incentives. These instruments are needed to encourage environmentally responsible decision-making by investors, consumers and other economic actors. Economic instruments aim to bridge the gap between the private and social costs by internalizing all external costs to their sources, namely the producers and consumers of resource depleting and polluting commodities.

Economic instruments are "instruments that affect costs and benefits of alternative actions open to economic agents, with the effect of influencing behavior in a way that is favourable to the environment". There is a wide range of economic instruments or incentives, which can be used to internalize externalities of economic activities. Every incentive that aims to induce a change of behavior of economic agents by internalizing environmental or depletion cost qualifies as an economic instrument.

A very general classification of economic instruments is, to divide them into two groups. The first group is the so called market-based instruments (MBI). This covers all instruments and incentives that work by a change of either product or factor prices, e.g. taxes or pollution charges. Such instruments generate in one or the other way income for the governments. The second group is the non market-based instruments, such as command and control activities or land reclamation bonds.

A better and more accurate typology of economic instruments was proposed by Panayotou (1994). He classified economic instruments into the following categories:

- property rights
- market creation
- fiscal instruments
- charge systems
- financial instruments
- liability instruments
- performance bonds and deposit refund systems

Property Rights

As already stated, inadequately defined and insecure property rights can be one of the reasons for environmental depletion and pollution. Therefore, the establishment of secure (and tradable) property rights will lead to more appropriate pricing of the use of natural resources. Establishing secure and transferable property rights will ensure that cost of depletion is internal to the user and that will ensure the sustainable use of his property. In case of somebody polluting or using natural resources from somebody else in a specific area, secured and tradable property

rights will ensure that they will negotiate with each other and find a solution to internalize the externalities.

However, the assignment of property rights cannot solve all environmental problems. It is only useful under certain circumstances and conditions. For example, the assignment of property rights is not feasible if there are a lot of users of a specific environmental commodity, such as air or water, since exclusion of other users is technically not possible. In such a case alternative instruments must be used to ensure the environmentally sound use of the commodity.

The assignment of secure and tradable property rights would have the following advantages:

- transaction costs are very low,
- internalized forever and no further intervention is necessary,
- administrative costs are low (after property rights are assigned),
- they adjust automatically to changing circumstances,
- unlike changes of prices, the market distortions are very low,

and also limitations:

- it is a politically sensitive issue, since it can be used to achieve political objectives (e.g. reward political supporters),
- it is difficult to distribute property rights. Since they carry a lot of value (rents from future activities) they should not be given away, but on the other hand selling them in an open market would exclude poor people from buying them and therefore would have social implications.

Market Creation

This type of instrument internalizes environmental damages on the production side because the government creates a market to use the environment as a waste sink or issues pollution permits. These rights can be bought and sold like any other commodities. An example for market creation is the tradable pollution permits that allow a company to buy or sell the rights to pollute the environment with an allowable level of pollution. This ensures that a specific level of pollution or emission will be attained at the lowest cost to society.

Individuals or companies using the environment would have to pay pollution charges either directly to the government or they would have to purchase pollution permits. Pricing the use of the environment as a waste sink would internalize the cost of waste into the product prices and therefore in the long run reduce the waste per unit of output. This is also an instrument that can ensure that the environment is only affected as far as it can tolerate such impacts. To achieve sustainable use of the environment by charging for polluting it, it is essential to ensure that the

environment is used below its self-healing-capacity. Otherwise economic activities would still be continued at an unsustainable level, although less than it would be without the pollution changes.

Among the advantages are:

- if the permits are initially sold, the government can receive revenues,
- specific pollution standards can be obtained, including a maximum of pollution which is allowed,
- it is possible to focus on regional environmental problems,
- from an administrative point of view tradable pollution permits are quite easy to handle. after the initial permits are issued, the government is not involved any more,
- this instrument is very flexible because, in case the level of pollution should be reduced, the government and NGO's can buy up the permits.

While the disadvantages are:

- difficult to control and supervise the given pollution rights,
- more wealthy and competitive industries are able to push less wealthy industries or companies out of the market. From an economic point of view this might be efficient, but it may also lead to a situation where industries may reach monopolistic or oligopolistic situations,
- it is difficult to find a threshold for the environmental pollution that is below the environment's self-healing-capacity,
- from an emotional point of view it is difficult to convince the public that the rights for polluting the environment is an instrument to save the environment, since this looks very contradictory in nature,
- with this instrument it is difficult to take transboundary effects of pollution into account,
- new enterprises might decide to establish a factory in other regions or countries where there are no, or lower limitations for pollution,
- tradable pollution rights can only consider selected hazardous factors such as SO2 or heavy metals. It is not possible to cover the whole range of environmentally harmful agents.

Fiscal Instruments

Fiscal instruments such as taxes or subsidies for environmentally sound production can be used for full cost pricing of production and consumption. For example current prices of petrol or pesticides do not incorporate the social costs of these products. Their effects on human

health or the environment are not considered at all. Fiscal instruments therefore try to bridge the gap between the private and social cost of production and consumption. Ideally, the taxes or subsidies should be equal to the marginal environmental damage caused by a certain activity. If this were the case it would adjust the price of a good exactly by the amount of reduction in social welfare caused by the externalities associated with such a product. Taxation of environmentally hazardous products is a rather old instrument which was already proposed by Pigou in the early twenties of last century. Environmental taxes can be imposed on the production side (e.g. taxation of raw materials) as well as on the consumption side (e.g. taxation of petrol or pesticides).

The advantages are:

- from an economic and an ecological point of view, fiscal instruments are very efficient,
- after imposing a green tax for example, every further reduction of the use of hazardous products leads to a win of revenues, since individuals or companies save money because they do not have to pay taxes for each unit of the hazardous product they did not use,
- even low taxes (below the social cost) will induce a more environmentally friendly production,
- taxes encourage enterprises to develop or introduce cleaner production techniques since they will then save taxes,
- this instrument will leave private enterprises the freedom to decide whether they pay taxes or invest in cleaner production technology.

While the disadvantages are:

- politically there is a tendency to impose low taxes which do not cover the whole social cost. This decision is usually pushed by different lobbies,
- there is also a tendency to use taxes to create revenues for the government. This should not be the aim of such taxes, since it would probably lower the acceptance of such a taxation,
- it is difficult to consider regional aspects of pollution,
- inflation may decrease the effects of a taxation on environmentally bad products,
- high administrative costs,
- low willingness to accept by the public as well as by the target group concerned.

Polluters will react automatically to the tax by reducing emissions to the level where the unit rate of the tax and the marginal pollution

abatement cost (that is, the cost of removing one additional unit of pollutant) curve increases from right to the left (Figure 2) because the more a pollutant is abated, the higher the unit (marginal) costs. If a tax with a rate t_1 is imposed, the polluter will abate pollution from C to P_1 because beyond this level (B on MAC) it is cheaper to pay the tax than to abate emissions further. Obviously the higher the level of the tax, the higher the level of abatement (for example, with a tax t_2 the level of the

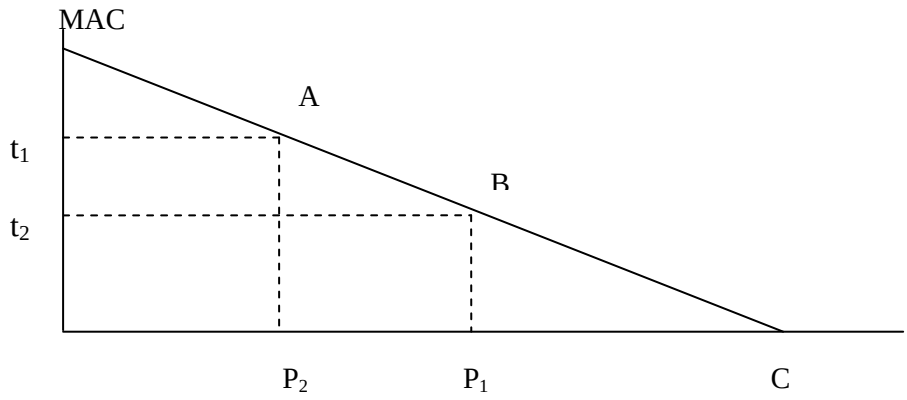

Figure 2. Pollution tax and the level of abatement

abatement is $CP_2 > CP_1$). Assuming marginal abatement functions are reasonably obtained with an appropriate level of tax. The consequences of pollution taxes can be better understood when referring to what economists call the optimal level of pollution. This optimum level corresponds to the point where MAC equals marginal damage costs (MDC). Any departure from this level (Point A in Figure 2) implies a welfare loss, because either pollution damage exceeds abatement costs (moves to the right of A on MDC) or abatement costs are higher than damage costs (move to the left of A on MAC). Ideally the pollution tax should be fixed to obtain this optimal level: a tax fixed at level t^* would achieve the optimal pollution level P^* (Figure 3). This of course implies that the marginal damage costs can be estimated, a condition difficult to fulfill in reality. It is interesting to see that with a tax t^*, the payment of the polluter can be divided into three parts: surface P^*AB, which is the total pollution abatement cost (surface under MAC); surface OAP^* which is the residual damage tax, corresponding to the residual damage OP^*(surface under MDC); and surface Ot^*A, that is, a residual tax which can be interpreted as the payment of a tax for using scarce environmental resources. Note that surface OAB reflects the total value of the

internalized environmental costs (abatement costs plus damage costs). We can see that the tax imposes an additional burden on the polluter who pays the abatement costs (P^*AB) plus the tax (Opt^*AP). If an emission standard P^* was imposed, the polluter would only pay the pollution abatement costs.

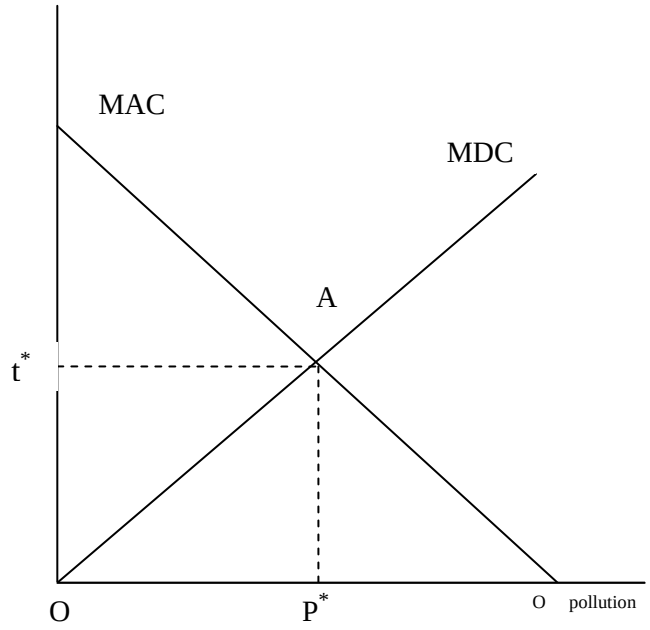

Figure 3. The optimal level of pollution

Financial Instruments

Financial instruments could give incentives to support environmentally friendly activities or projects with positive externalities, such as reforestation or advanced techniques to control soil erosion. Financial instruments such as revolving funds, green funds, subsidized interest rates or soft loans may be justified as instruments for mobilizing additional financial resources for conservation, environmental protection and sustainable development. Financial instruments might be effective under certain circumstances and conditions, but they are mostly considered to be too blunt for an efficient internalization of social costs, since they only encourage a certain form of behavior but do not internalize costs.

Liability Systems

It would seem a priori logical to require polluters to pay for the damage they cause. In fact this would be economically efficient and equitable if victims received full compensation for the entire damage they suffer.

Assume that the damage costs caused by a polluter are perfectly known (line MDC in Figure 3).

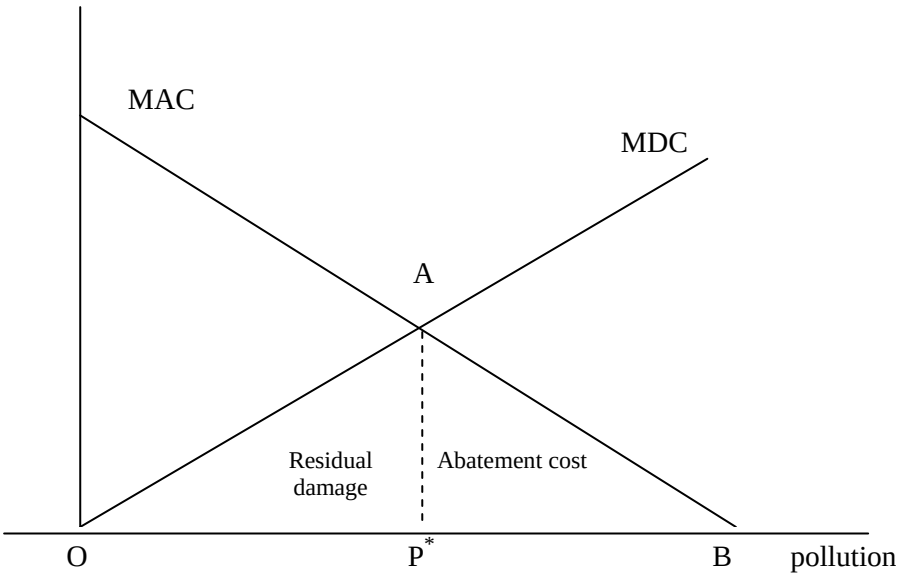

Figure 4. The ideal optimal level of pollution

The polluter will compare the pollution abatement costs (MAC) and will reduce the emissions as long as it is cheaper to do so than to pay the damage costs (that is, when MDC = MAC, point A in figure 4). We know that this level of pollution, P^*, is called the optimal pollution level because costs and benefits are equal at the margin (benefits are defined as the damage avoided). The fact that polluters pay abatement costs plus the cost of residual damage results in a 'full internalization' of environmental costs.

Hence damage compensation constitutes an efficient approach. But this requires a number of conditions to be met:

- that damage costs are correctly evaluated,
- that polluters and victims can be identified,
- that the casual relationship between pollution and damage can be established,
- that such a procedure can be enforced without excessive complexity and costs.

These conditions are obviously difficult, if not possible, to fulfill in reality, so that environmental policies mainly rest upon direct regulations and various types of economic instruments as described above.

Performance Bonds and Deposit-Refund Systems

Both systems are aimed at shifting responsibility for controlling, monitoring and enforcement to individual producers and consumers who are charged in advance for the potential damage. In any case the state has to pay the bill for environmental damages caused by the activities of single users of the environment. This could be avoided by introducing a deposit refund system, environmental bonds or similar incentives. This would make sure that companies act in compliance with environmental rules and use the environment in a sustainable matter. After proving this, individuals or companies can get their bonds refunded. If they have damaged the environment the bonds can be used by the government for cleaning up the environmental damages. Again, even if the controlling is done through the companies, the administrative costs are quite high.

Remove Subsidies

In many cases governments are effectively subsidizing environmental bads. For example, the applications of a carbon tax where governments are paying subsidies for the production of electricity are likely to be relatively ineffective. Before starting to assess the use of economic instruments, it is necessary to detect such unsustainable market distortions and reduce them. Perhaps this might already be sufficient to induce environmentally friendly production and no further action might be necessary.

The above mentioned instruments might give the impression that persons or companies always need to be forced by certain rules or regulation to take care of the environment. But a more efficient and cost effective way to achieve cost internalization is to induce self-regulation on the polluters side. In most of the cases the polluter knows best how to control their hazardous output or environmental damages.

Selecting and Implementing Process

Since each instrument has its advantages and disadvantages it would seem that it would be easy to select the appropriate instrument for a given environmental problem. But before imposing a certain instrument or mix of instruments it is necessary to consider all economic, political, social and cultural constraints to make sure that the desired outcome is achieved. Therefore it is difficult to give guidelines as to which instrument should be used in which case. These must always be considered on a case by case approach to ensure that the environmental goals will be met. The decision-making process for selecting the most appropriate instrument necessitates the following steps:

- an assessment of the status of the environment must be made. It is necessary to have full information on the kind of problem, its

roots, gravity and its current and future effects on the environment,

- the key issues need to be defined. This is necessary because it is too ambitious and in some cases not even possible to solve or address all problems at the same time. Therefore it is necessary to focus on the most serious impacts first,
- it is necessary to define which goals should be achieved. Should the emission of certain by-products be stopped because they have very serious impacts or is it enough if they are only reduced by a certain amount? What is the time frame for achieving this goal? Is it required to stop or reduce the emission now, because of its significant impacts or in a longer period of time, which would allow the sectors concerned to adapt,
- finally, it is important that the most appropriate instrument or mix of instruments should be selected. In this regard the following questions have to be taken into account:
  - Will the instrument effectively achieve the environmental goal?
  - Will the approach be cost effective; i.e. will it achieve the environmental goals at the least cost (to society at large)?
  - Will the instrument provide relevant government agencies with the information they need?
  - How easy (or costly) will the monitoring and enforcement be?
  - Will the instrument be flexible in the face of change? When changes occur in tastes, technology, or resource use, will the policy accommodate these changes and remain effective or will it be in danger of becoming ineffective or even counter productive)?
  - Will the instrument provide industry with positive and dynamic incentives? For example, will it encourage firms to retain existing, inefficient plants?
  - Will the economic effects of the instrument be equitably distributed?
  - Will the purpose and nature of the instrument be broadly understandable to the general public?
  - Will the instrument be politically acceptable, and feasible in terms of implementation?

During this stage it is also important to consider how this instrument could be implemented and whether there are social, cultural, economic or political constraints, which would hinder the implementation of the selected instrument. Considering the above questions will lead to a

specific instrument or a mix of instruments which would be appropriate to internalize given externalities of economic activities. Developing an implementation plan, i.e. consideration should be given to the ministries involved, legal aspects, financial aspects, timing etc. During the last stage, the whole process of implementation should be monitored and evaluated. Is the imposed instrument leading in the right direction? Are there any side effects, which could not have been foreseen? Is the instrument accepted by the target group concerned as well as by the public? If serious problems occur, these should lead to a change of policy. The evaluation process should also lead to recommendations for future activities in this field.

SUGGESTED ECONOMIC INSTRUMENTS FOR MANAGING INDUSTRIAL WASTE

Economic instruments are often based on the polluter pays principle (PPP). Pollution fines are common; for example, in the Philippines fines are used to complement the enforcement of emission standards, and are based on the duration of the violation, and environmental conditions prevailing at the time, the quantity of effluent discharged, and the average deviation from the effluent or emission standards (Government of the Philippines 1992). Among the East Asian countries, Japan and the Republic of Korea have both adopted the PPP although, in Japan, it is yet to be applied comprehensively to pollution control because of existing systems of financial subsidies and tax credits. In Malaysia, discharge fees have been in use since 1978 to complement a regulatory approach towards solving water pollution from palm oil mills (Panayotou 1994). With the gradual imposition of more stringent standards and higher discharge fees, biological oxygen demand in public water bodies dropped steadily from 222 ton per day in 1978 to 58 in 1980 and 5 in 1984 (Malaysia 1994).

In the Pacific Islands, almost no economic instruments are yet used as tools for environmental management. A lack of experience with such mechanisms, the important role of the informal economy and the traditional role of 'custom' in resource management at the local level, all are weigh in against market-based instruments. Nevertheless, the possibility of increased impacts stemming from globalization will make it essential for countries to consider the role that such mechanisms may need to play in future. While economic and fiscal instruments are being promoted for many environmental uses in Australia, the opposite seems to be occurring in New Zealand, where the only fully-developed example of an economic instrument at present is a transferable quota system used to manage the major fisheries. The best-known economic instruments

were the deposit-refund schemes that once operated for soft drink, beer and milk bottles. These disappeared in the 1980s as the growth of supermarkets and centralized distribution centres favoured plastic containers over glass ones.

The "polluters pay" principle can be applied to the producers of industrial wastes, which exceed the handling capabilities of sewage treatment plants. In Malaysia, Department of Environment, Standards and Industrial Research Institute of Malaysia (SIRIM) Berhad and local government has established standards for industrial waste management. Any discharges, which exceed these allowable standards, can be subject to a discharge fee that is set at a high enough level to motivate industries to treat their wastes and bring them into compliance with the Department of Environment and SIRIM standards. Based on the same polluters pay principle, government can also consider the possibility of levying specific taxes on environmentally damaging products. These taxes can be aimed at reducing application of products whose environmental effects are difficult to monitor and control, such as pesticides, fertilizers, ozone depleting substances (e.g. CFCs), batteries, fuels and hazardous substances such as dry cleaning fluids.

Tax incentives could also be considered for encouraging recycling and the use of environmentally friendly technologies. In Malaysia, soda bottles are already recycled under a deposit-refund scheme operated by bottlers. Additional recycling and recovery activities can be promoted through the use of deposit fees charged to buyers of goods such as automobiles, tires, plastic bags, batteries and cans. Improper disposal of these items threatens the beauty and health of Malaysia's fragile environment and poses a health hazard to its citizens. Deposits would therefore be refunded at the time of proper disposal, which could be at a recycling facility or official landfill.

Use of deposit-refund schemes could have another important economic effect -- encouraging to collect litter and lay which are basis for development of new recycling industries such as the processing of tyres into tyre derived fuel for boilers, asphalt road additive, or roof tiles and fabrication of recycled plastics and metals. Such a scheme should be operated on a self-financing basis, for example, by covering costs from interest earned on the deposit fund. A possible institutional mechanism would be license operations to a suitable non-government organization (NGO).

COSTS AND BENEFITS OF RECYCLING

Economics of the recycling operation is governed by four main factors, namely:

- costs associated with recyclable collections system and recycling rate from the beginning of the waste generation point;
- revenue gained by selling of the recycled materials;
- costs associated with the transportation and disposal of waste materials; and
- costs associated with the resource savings due to recycling.

It should be well recognized that a recycling operation alone cannot be either economically viable or self-sustaining in the present market mechanism unless the above-mentioned factors are considered altogether. To illustrate the profits of resources recovery from recycling an example of one factory located in Bandar Baru Bangi, Selangor has been selected. If the factory maintain its current waste manufacturing process and technology, while expecting wastes generation increasing 2% per year, the costs of toxic and hazardous wastes treatment will increase significantly. Taking only costs of treatment and transportation the increase is shown in Table 1.

The factory has to increase its budget to cover the increasing costs of treatment, by the 20th year with 2% toxic and hazardous waste generation.

Table 1. Treatment costs for schedule waste generation increase at 2% per year

Type of Waste		Acid	Nickel chromate	Zinc Hydroxide
Wastes generation ton per year	Initial year	38.40	1,440.00	20.40
Solidification treatment cost per ton (RM)		1,440.00	810.00	810.00
Transportation costs per ton (RM)	Factory in Bandar Baru Bangi, Selangor	60.30	60.30	60.30
Total costs per year (RM)	Business as usual in initial year	57,611.52	1,253,232.00	17,754.12
Total costs per year (RM)	5th year	63,948.79	1,391,087.52	19,707.07
Total costs per year (RM)	10th year	70,286.05	1,528,943.04	21,660.03
Total costs per year (RM)	15th year	77,775.55	1,691,863.20	23,968.06
Total costs per year (RM)	20th year	85,841.16	1,867,315.68	26,453.64

However if the factory set a target to achieve resource recovery through recycling with target of certain percentage at certain year as stated in Table 2, the factory will gain profits.

This scenario will change and shows that the company will gain profits from reduction of wastes generation through reduction of costs of schedule waste treatment as percentage of waste being recovered increased. The gross profits that the factory will achieved in 20th year

from initial year were RM 40,328.06 for acid waste, RM 877,262.40 for nickel chromate waste and RM 12,427.88 for zinc hydroxide waste. Rather than to spend more on treatment of the wastes, recovery allows the factory to save costs. However the net profit from recovery activity will have to take into account the initial costs of investment to enhance technology, system and capacity to increased wastes recovery capacity as stated above. This investment and additional costs will only affect the factory net profit in the initial year, and the profits will increase as more wastes being recovered and decreasing wastes volume were send for treatment, while decreasing other associated costs. This illustration shows that profits received by factory who recover their waste through reducing costs that they should pay if they have to send for treatment at designated facility. Thus the resource recovery through recycling will help industry to reduce their costs of manufacturing and could concentrate on producing environmental friendly products.

Table 2. Treatment costs for schedule waste with recovery of waste conducted as stated

Type of Waste			Acid	Nickel chromate	Zinc Hydroxide
Wastes generation ton per year			38.40	1,440.00	20.40
Solidification treatment cost per ton (RM)			1,440.00	810.00	810.00
Transportation costs per ton (RM)	Factory in Bandar Baru Bangi, Selangor		60.30	60.30	60.30
Total costs per year (RM)		Business as usual in initial year	57,611.52	1,253,232.00	17,754.12
Total costs per year (RM)	10% Waste Recovery	5th year	51,850.37	1,127,908.80	15,978.71
Total costs per year (RM)	20% Waste Recovery	10th year	46,089.22	1,002,585.60	14,203.30
Total costs per year (RM)	50% Waste Recovery	15th year	28,805.76	626,616.00	8,877.06
Total costs per year (RM)	70% Waste Recovery	20th year	17,283.46	375,969.60	5,326.24

THE OPTIMAL LEVEL OF RECYCLING

Recycling is economically efficient if the resources used in the process do not exceed the resources saved by recycling. It is necessary to balance the marginal costs and benefits of recycling in order to determine the optimal recycling level, rather than just setting some arbitrary target.

The benefits from recycling include avoided disposal costs, avoided external costs associated with disposal (leachate, bed odour, etc.), and the revenue from the sale of recycled materials. These should be balanced against the costs associated with recycling, such as extra cost incurred due to the separation of recyclables from mixed waste, costs associated with any process involved in recycling.

Thus the condition for setting optimal target for recycling is:

$$P_R + C_D + C_{DE} = C_{SC} + C_R + C_{RE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:

P_R = price of recycled materials
C_D = marginal cost of disposal
C_{DE} = marginal environmental cost of disposal
C_{SE} = marginal cost of separate collection
C_R = marginal financial cost of recycling
C_{RE} = marginal environmental cost of recycling

The left hand side of equation (1) is the benefits of recycling. The right hand side is the cost of recycling. Hence (1) simply says:

$$MB_R = MC_R \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Suppose for simplicity, $C_{RE} = 0$, then (1) can be rearranged as:

$$-(P_R - C_{SC} - C_R) = C_D + C_{DE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

or:

$$-\Pi_R = C_D + C_{DE} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Thus the condition for 'optimal recycling' is that recycling should be subsidized up to a level determined by the sum of the avoided waste disposal costs plus the avoided environmental cost of disposal. The socially desirable recycling level occurs when the marginal loss ($-\Pi_R$) on recycling is just equal to the marginal financial and environmental cost of disposal.

By transferring the saved financial cost of disposal to recycler, the 'financial optimum' can be reached. This optimum level of recycling can be achieved by introducing:

- a recycling credit of C_D,
- a further recycling subsidy of C_{DE} or
- a credit of C_D and a tax or levy on waste disposal of C_{DE}.

CONCLUSION

In Malaysia, almost no economic instruments are yet used as tools for the improvement of industrial waste management. It was not realized that economic instruments can be used for improving industrial waste management because of lack of experience with such mechanisms and the necessity of the important role of the informal economy and the traditional role of 'custom' in resource management at the local level. These economic instruments can be used as an indicator for the improvement of waste management in Malaysia. Nevertheless, the possibility of increased impacts stemming from globalization will make it essential for Malaysia to consider the role that such mechanisms may need to play in the future.

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