HOW TO REDUCE WASTES AND SAVE MATERIALS

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INTRODUCTION

Wastes either liquid or solid, are inevitable products of most of man's activities, whether urban or rural. Their type, amount and composition varies with the type of activity, be they domestic, industrial or agricultural in nature. Take the case of solid wastes. The waste that comes from agricultural, domestic, commercial, industrial as well as construction activities are composed of a wide variety of materials such as food wastes, construction wastes, papers, plastics, metals, garden wastes, factory offsets and process wastes, medical wastes and other discarded and residual items. Components that typically make up solid wastes in some cities in Malaysia are given in Table 1. The volume of wastes generated in major cities of Malaysia has also increased over the years due to increase in population, socioeconomic activities and physical development. Based on the statistical data during the 1980s, the quantity of municipal solid wastes of most of the urban centres have more than doubled in size. Johor Bahru which has the highest cost of living and is still rapidly expanding is no doubt producing an increasing volume of waste over the years due to the various development activities. The Johor Bahru Municipal Council collects more than 0.5 kg of waste per person per day amounting to about 400 tonnes per day. This figure is expected to increase to more than 0.8 kg/person/day by the year 1995 (Fan and Kheng, 1986).

If improperly handled, these wastes will be a source of land, air, surface water and groundwater pollution. They must be collected, treated and/or disposed off properly. In order to achieve this, a good management system will have to be implemented and sufficient funds as well as skilled manpower be made available. With increasing costs of wastes handling, one of the attractive options of managing such wastes is to look into the possibility of wastes minimization and recovery.

Table 1 Waste Composition in Some Municipal and District Councils

Components	Petaling Jaya	Kota Tinggi	Seberang Prai	Johor Bahru
Organic Food	48.3	5.0	37.8	45.0
Paper/Cardboard	23.6	25.0	28.0	19.0
Plastic/Rubber	9.4	6.0	8.4	12.0
Textile	4.0	2.0	1.3	5.0
Yard Waste	4.8	5.0	10.5	7.0
Glass/Ceramic	4.0	3.0	0.3	3.0
Metal	5.9	1.0	4.0	9.0
Miscellaneous	-	47.0	9.7	-

Source: Pillay, 1986; Lokman and Fadil, 1992

WHY REDUCE WASTES?

The main reason for the need to reduce wastes is "to protect the environment". We have an obligation to leave our descendants something better than the accumulated litter of our squandering habits. This is in recognition of the fact that our world is finite and that the continued pollution of our environment will, if uncontrolled, be difficult to rectify in the future. Minimizing wastes will have the effect of reducing the strain on the carrying capacity of natural systems to receive or assimilate such wastes.

A second reason for the need of wastes reduction is to minimize costs. One of the important steps in wastes management is collection, which may take the form of sewers in the case of liquid wastes or some form of transportion system in the case of solid wastes. Such collection systems are very costly. The collection of solid wastes, for example, is estimated to represent 60 to 80% of the total management costs (Tchobanoglous et at 1979). In Malaysia, it has been reported that the amount spent for every ton of waste generated is approximately RM30 (Abu Bakar and Maheswaran, 1978). In the year 1986, for Kuala Lumpur alone, RM42 million was spent in managing the refuse. Obviously, great savings will be made if we have less wastes to be handled.

A third reason for the need to reduce wastes is to minimize wastage. Our high-waste, low recycle lifestyle is inherently wasteful of a bountiful endowment of natural resources. As can be seen in Table 1, a significant proportion of our wastes are non-biodegradable. "Wastes" such as rubber tyres, broken glass, building rubble and agricultural by-products such as coconut husks and shells have potential applications in a number of useful life activities. In this way, not only that we solve our environmental problems, but we also put such "wastes" to economic use.

HOW WE CAN REDUCE WASTES AND SAVE MATERIALS.

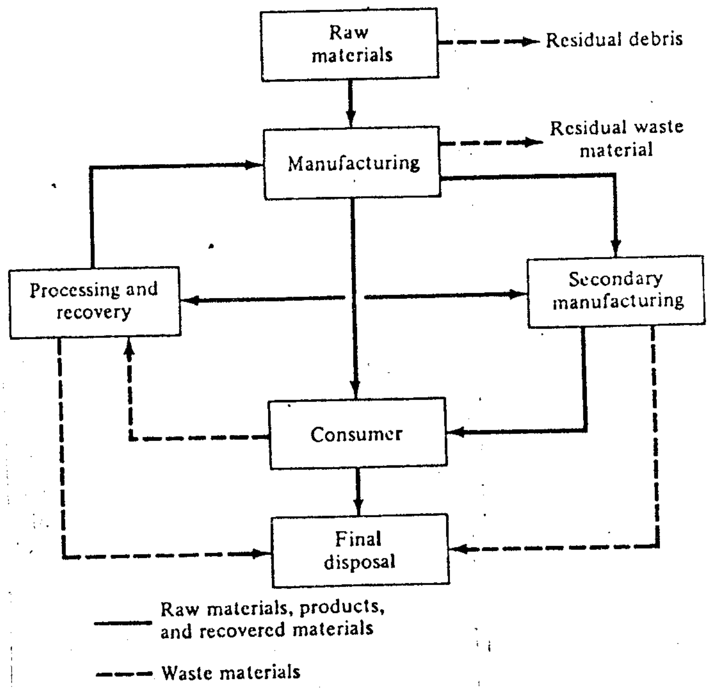
Solid Wastes

It is apparent from Figure 1 that one of the best ways to reduce the amount of solid wastes to be disposed is to reduce the consumption of raw materials and to increase the rate of recovery and reuse of waste materials (Peavy et al, 1986):

a) Reduction in Raw Materials Usage

If a reduction in the usage of raw materials is to occur either the input or output must be reduced. Raw materials usage can be reduced most effectively by reducing the quantity of municipal and industrial wastes. For example, to meet EPA mileage restrictions, American cars are now (1984) on the average, 20% smaller than they were in the late 1950s and early 1960s. This reduction in size has also reduced the demand for steel by about 20%. The reduced demand for steel has in turn resulted in less mining for the iron used to make steel.

Figure 1 Generalized Flow of Materials and the Generation of Solid Wastes in Society (source: Peavy et al, 1986)



Reduction in the quantities of waste can occur in several ways: (1) the amount of material used in the manufacture of a product can be reduced, (2) the useful life of a product can be increased, and (3) the amount of materials used for packaging and marketing consumer goods can be reduced. For example, the quantity of automobile tyres now disposed off on an annual basis could be cut almost in half if their useful life (or mileage) were doubled (Peavy et al, 1986).

) Recovery and Reuse of Waste Materials

A number of materials present in municipal and industrial solid wastes are suitable for recovery and reuse. Referring to the percentage distribution of the waste components reported in Table 1, it would appear that paper, cardboard, plastics, glass, rubber and metals are the most likely candidates. Reuse of such waste materials not only saves on the cost of purchasing new materials but also on the cost of removal and disposal of the old material. One of the area that has been identified as being a feasible area to use them is the construction industry. A list of waste materials and their current uses by the highway industry in the US given in Table 2 serves as an excellent example in this respect.

Table 2 Summary of Waste Materials and their Current Uses in the US Highway Industry (source: Imtiaz, 1991)

Waste Material	No. of States Using the Material	Material Used As Addditive To				Materials Used As				Landscaping (see 2)	Other (See 2,3)
		Wearing Course	Base	Subbase	Subgrade/ Embankment	Wearing Course	Base	Subbase	Subgrade/ Embankment		
Reclaimed Paving Materials	41	23	26	14	5	8	16	8	5	-	3 (sh)
Coal Fly Ash	31	20	5	6	4	1	2	-	2	-	9(cc),1(us)
Rubber Tires	29	21	6	1	2	-	1	-	3	-	11(cs)
Blast Furnace Slag	15	4	2	-	-	3	5	3	2	2	1(sb)
Steel Slag	9	4	2	1	-	1	2	-	2	1	1(lc)
Coal Bottom Ash	7	2	2	1	1	-	1	1	1	-	3(lc), 1(sc)
Used Motor Oil	7	-	-	-	-	-	-	-	-	-	3(recy), 3(apf)
Boiler Slag	7	4	1	-	-	-	1	1	1	-	3(lc), 1(sc)
Waste Paper	6	-	-	-	-	-	-	-	-	5	1(recy)
Mine Tailings	5	-	-	-	-	-	-	-	5	1(sa),2(c/f)	-
Sewage Sludge	3	1	-	-	-	-	-	-	1	-	-
Building Rubble	2	-	1	1	-	-	-	-	-	-	-
Waste Glass	2	1	2	-	-	-	-	-	2	-	-
Sawdust	2	-	-	-	-	-	-	-	1	-	-
Ceramic Waste	2	1	1	1	-	-	-	1	1	-	1(pb)
Incinerator Residue	2	2	1	-	-	-	-	-	-	-	-
Highway Hardware	2	-	-	-	-	-	-	-	-	-	2(recy)
Foundry Waste	1	1	1	-	-	-	-	-	-	-	-
Scrubber Sludge	1	-		-	-	-	-	-	1	-	-
Phosphate Slag	1	1	-	-	-	-	-	-	-	-	-
Straw	1	-	-	-	-	-	-	-	-	1	-
Plastic Waste	1	1	-	-	-	-	-	-	-	-	-
Lime Kiln Dust	1	-	-	1	1	-	-	-	-	-	-

Notes:

1. Of the 42 states who responded to the questionnaire.
2. The number under each column shows the total number of states that currently use the material in the respective application.
3. Abbreviations used : sh-shoulders, cs-crack sealers, cc-plain/structural cement concrete, us-under seal, lc-lce control, sc-seal coat, sb-sand blasting, recy-recycling, apf-asphalt plant fuel, pb-pipe bedding, f-fertilizer, c-compost, sa-sol. acration.

Presently, the waste materials used in construction of highways and buildings are confined more towards less demanding structures that do not require heavy duty application, for example low volume roadways or the construction of service bays and non-load carrying members in a building structure. However, that scenario is changing as better waste materials become available for the construction industry (Badaruddin, 1993). A list of some common waste materials and their current as well as potential uses are given in Table 3.

Table 3 List of Some Common Waste Materials and Their Applications (source: Badaruddin, 1993)

Waste Material	Current/Potential Uses
Rubber Tyres	asphalt rubber in hot bituminous structures; as light weight aggregates; fish breeding aid; subgrade for poor soil; erosion control of roadway embankments.
Broken Glass	Manufacture of new glass; used as aggregates in landfills, asphalt mixtures and in portland cement concrete; pavement construction for low volume roads, city streets, driveways and parking lots; as a hardcore in building construction.
Building Rubble	Broken bricks and masonry-used as a roadway subbase and base layers; as hardcore in building construction; lining sewage treatment beds. Waste roofing material - used as paving mixture.
Old Bituminous and Concrete Pavement	recycled as pavements
Oil Palm and Coconut Kernel Shells	Unpaved road surfaces; substitute for aggregates in hot or cold mix asphalt and portland cement concrete construction.
Coconut Kernel Shells	Mosquito repellent coils; joss sticks; burning fuel for cooking; activated carbon.
Coconut Husks	Fibres used for making ropes; in domestic cleaning chores and as fillers in cushions; erosion control mat for slopes and landscape; fibre-reinforced bituminous concrete for paving.

Liquid Wastes

Another category of wastes that has potential for reuse and lead to savings are treated wastewaters. Ultimate receptors of treated wastewaters include surface water and groundwater bodies, land surfaces, and in some instances, the atmosphere. Recognition of the value of wastewater as a water resource has resulted in an increase in the reuse of treated effluents, particularly in water-scarce regions. In order to make this possible, disposal sites or reuse facilities must be found within a reasonable distance of the wastewater treatment plant because of the cost of transporting the effluent over long distances. However, since wastewaters may contain a few viable pathogens even after extensive treatment, both disposal and reuse must be accomplished with due caution.

Wastewater has been reused for several purposes. These include (Peavy et al, 1986):

a) Creation or Enhancement of Recreational Facilities

Water quality requirements for recreational uses are quite stringent and some form of advanced wastewater treatment techniques will almost invariably be required prior to wastewater reuse for this purpose. Indeed, where body-contact activities such as swimming and water skiing are included, the quality of the water resource must approach that of drinking water with respect to most parameters. Recreational water should be aesthetically pleasing and essentially free of toxicants and pathogenic organisms. Two examples of wastewater reuse in recreational facilities often cited in the literature are the Santee Project and the Indian Creek reservoir, both in California.

b) Industrial Water Supply

The quality of water required for various industrial processes varies greatly. Cooling water generally has the lowest quality constraints, while boiler water has the highest. The degree of treatment given to wastewater will obviously be dictated by the intended industrial use. Cooling processes, which constitute the largest water requirement in most industries, may be able to use secondary effluent directly, although additional solids removal is desirable and additional treatment with biocides may be necessary to prevent biofouling of surfaces.

c) Groundwater Recharge

Wastewater can become part of groundwater as an inadvertent consequence of land application for irrigation or from rapid infiltration systems designed for wastewater disposal. However, groundwater recharge will be considered a planned activity with well-defined objectives. These objectives may include stabilizing the groundwater table, creating hydrostatic barriers to prevent saltwater intrusions into freshwater acquifers, and storing water for future use.

d) Reuse in Potable Supplies

The intentional use of wastewater as a part of the potable supply is a more recent occurrence. This reuse is usually necessitated by a shortage of natural water. Reuse may be direct or indirect. Direct reuse is usually referred to as closed loop or pipe-to-pipe recycling, which indicated that the treated effluent from the wastewater treatment system is piped directly to the influent of the water treatment plant. An example of direct reuse is what has been practiced in Windhoek, South-West Africa since 1969. Indirect reuse involves storage of treated effluent in natural or artificial water bodies for a period of time prior to withdrawal and incorporation into the water supply. Indirect reuse is the more acceptable practice at the present time.

EXPLORING WASTE MINIMIZATION POTENTIALS - ROLE OF R & D

Since the concept of wastes minimization through reuse and recycling sounds environment-friendly and leads to potential cost savings, much study are being carried out to determine the characteristics of each material and explore their potential uses. A list of R & D activities looking into the possibility of utilizing wastes for a variety of purposes in UTM is given in Table 4.

Table 4 List of R & D Activities on Waste Utilization in UTM

Area of Research	Researchers	Faculty
Use of palm oil as bitumen and rejuvenator	Hasanan Md. Nor et al (1993)	Civil Engineering
Use of palm oil fuel ash and rice husk ash as partial cement replacement materials in mortar for building construction	Salihuddin R. Sumadi & Mohd. Warid Hussin (1993)	Civil Engineering
Use of palm oil fuel ash and pulverised fuel ash in brick making	Che Sobry Abdullah et al (1993)	Civil Engineering
Crushed palm oil clinker as biomass carrier in wastewater treatment	Anderson, G.K and Kassim, M.A. (1992)	Civil Engineering
Use of palm oil kernel shell for leachate treatment	Fadil Othman et al (1993)	Civil Engineering
Turning coconut shell and palm oil kernel shells into activated carbon	Normah Mulop et al (1992)	Chemical Engineeering and Natural Resources
Making zeolite from rice husks	Halimaton Hamdan et al (1992)	Science
Palm kernel shell as fuel feed or a small gasifier- engine	Azhar Abd. Aziz (1992)	Mechanical Engineering

The potentials of waste minimization and materials saving through reuse and recycling are too numerous to be cited here. Through research, greater uses could be found for materials that range from discarded rubber tyres,broken glass, building rubble and agricultural byproducts which were once discarded as trash and of no economic value.

CONCLUSIONS

Wastes, either solid or liquid, must be collected, treated and/or disposed off properly in order to avoid its negative impacts on the environment. With increasing costs of handling such wastes, one of the attractive management options available is wastes minimization through reduction in raw materials consumption as well as reuse and recovery of waste materials. Experience in a number of countries have shown that both solid and liquid wastes can be reused in a wide variety of ways i.e. either as materials for the construction of highways and buildings, materials for domestic, industrial and agricultural uses or facilities for enhancing the quality of life.. This list can be extended further through continuous R & D efforts. Since wastes reuse and recovery has a number of advantages (minimize negative environmental impacts, wastage and handling costs), municipal councils together with other similar waste management authorities should adopt this approach in handling wastes by introducing legislations and providing facilities and incentives for wastes recycling.

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