

Minimizing Waste to Safeguard Landfill and Environment

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Key words: Solid waste, landfill issues, environmental protection, waste reduction/minimization processes.

SUMMARY

Increasing municipal waste has been a major problem towards landfill issue and environmental degradation, especially for the limited land supply and congested environment of Hong Kong. It has been forecasted that the remaining landfill space will last only for another few years and the environment will continue to turn bad if waste levels keep escalating. In this research, we'll try to explore the current situation and possible means to resolve the landfill problems and its impacts towards environmental degradation/protection, through probable control at sources and waste reduction/minimization processes, from Government perspectives as well as what individual/society can do to help. Recyclable materials recovery and waste reduction methods will be revamped, through quantitative research by questionnaires to major stakeholders; to devise better strategy and methodology preserving the scarce land supply while enhancing environmental protection and public health.

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INTRODUCTION

Hong Kong has experienced rising wasteloads as its economy grows. Municipal wasteloads have in general been increasing since 1986 - mirroring Hong Kong's rapid economic expansion over the same period. The population has grown by more than one million people and each person is throwing away more waste. The per capita level of municipal solid waste disposal has risen from 1.28 kg. per person per day in 1991, to 1.36 kg. in 2007 (EPD, 2009). Municipal solid waste includes waste from households, industry and commercial operations, but landfills are also under tremendous pressure from construction waste. In 2006, HKSAR introduces the construction waste disposal charging scheme and the quantity of construction waste disposed of at landfills decreased from 6,560 tonnes per day in 2005 to 2,910 tonnes per day in 2007.

Hong Kong generates bulk solid waste including municipal solid waste (MSW), construction & demolition (C & D) waste, chemical waste and special wastes. MSW comprises solid waste from households, commercial and industrial sources. C & D waste includes waste arising from such activities as construction, renovation, demolition, land excavation and road works. Special wastes include clinical waste, animal carcasses, livestock waste, radioactive waste, grease trap waste and waterworks/sewage sludges. These wastes need to be treated separately. Chemical waste comprises substances specified under the Waste Disposal (Chemical Waste) (General) Regulation as posing a possible risk to health and the environment. Except chemical waste, all kinds of solid waste dispose of at landfills. The Waste Disposal Plan, published in 1989, sets out a strategy for municipal solid waste disposal in Hong Kong. Old waste facilities have been phased out and new, cost-effective facilities have been built to higher environmental standards, under the management of the EPD. The facilities include three strategic landfills and a network of refuse transfer stations. The three landfills have a total capacity of about 140 million cubic metres. Six refuse transfer stations and a system of refuse transfer facilities serving the outlying islands are in operation, with a total handling capacity of 8,800 tonnes a day.

Figure - Waste Facilities Serving Hong Kong

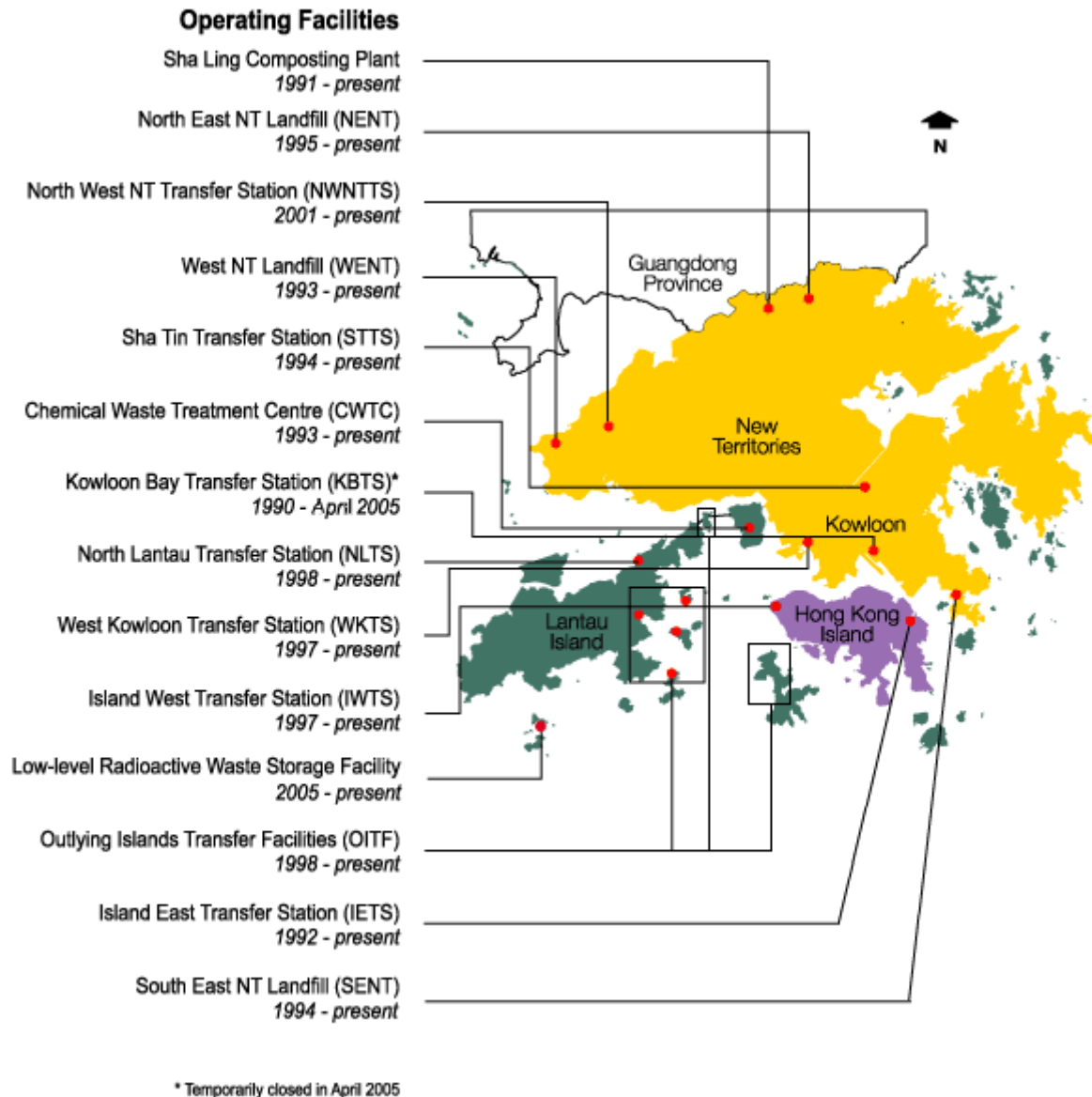


Figure - Program for Development of Waste Facilities

Waste Facilities	Date of Commission	Design Capacity	Capital Cost** (\$M)	Estimated Operation Cost** (\$M/yr)
<i>Strategic Landfills:</i>				
1. West New Territories Landfill	Commissioned on 19.11.93	61 Mm ³	2,200	150
2. South East New Territories Landfill	Commissioned on 26.9.94	43 Mm ³	2,600	170
3. North East New Territories Landfill	Commissioned on 1.6.95	35 Mm ³	1,100	130
<i>Refuse Transfer Stations (TS) :</i>				
1. Kowloon Bay TS*	-	-	-	-
2. Island East TS	Commissioned on 16.11.92	1,200 tpd	380	75
3. Sha Tin TS	Commissioned on 29.10.94	1,200 tpd	200	35
4. West Kowloon TS	Commissioned on 19.6.97	2,500 tpd	630	70
5. Island West TS	Commissioned on 1.5.97	1,000 tpd	640	45
6. North Lantau TS	Commissioned on	1,200 tpd	240	20

1.6.98				
7. Outlying Islands Transfer Facilities	Commissioned on 13.3.98 (Phase I & II)	610 tpd	300	40
8. North West New Territories TS	Commissioned on 14.9.2001	1,100 tpd	210	20
9. South East Kowloon TS	2016 (tentative)	3,000 tpd	750	90
<i>Special Waste Facilities :</i>				
1. Sha Ling Livestock Waste Composting Plant and livestock waste collection service	Commissioned in 1991	20 tpd	14	12
2. Chemical Waste Treatment Centre	Commissioned on 13.4.93	100,000 tonnes per year	1,300	338
3. Low-level Radioactive Waste Storage Facility	Commissioned on 19.7.05	133 cu.m	84.8	1.5

* Temporarily closed in April 2005.

** All costs shown for completed facilities are actual costs; the rest are estimated costs based on 2008/09 financial

The 3 strategic landfills are the West New Territories (WENT) landfill (Photo 1), the South East New Territories (SENT) landfill (Photo 2) and the North East New Territories (NENT) landfill (Photo 3).



Photo - West New Territories (WENT) landfill



Photo - South East New Territories (SENT) landfill



Photo - North East New Territories (NENT) landfill

It has cost nearly \$6 billion to build the three strategic landfills, with operating cost around \$400 million per year. Some 4.9 million tonnes of waste were landfilled in 2008. New solid waste management facilities should be developed unless there is a drastic waste reduction. Alternatively, another 400 hectares are required for new landfills, at \$12 billion to meet the needs upto 2030. Recycling or recovering the municipal solid wastes would be a way to solve the issue.

Figure - Quantities of Solid Waste Disposed of at Landfills in 1991-2007

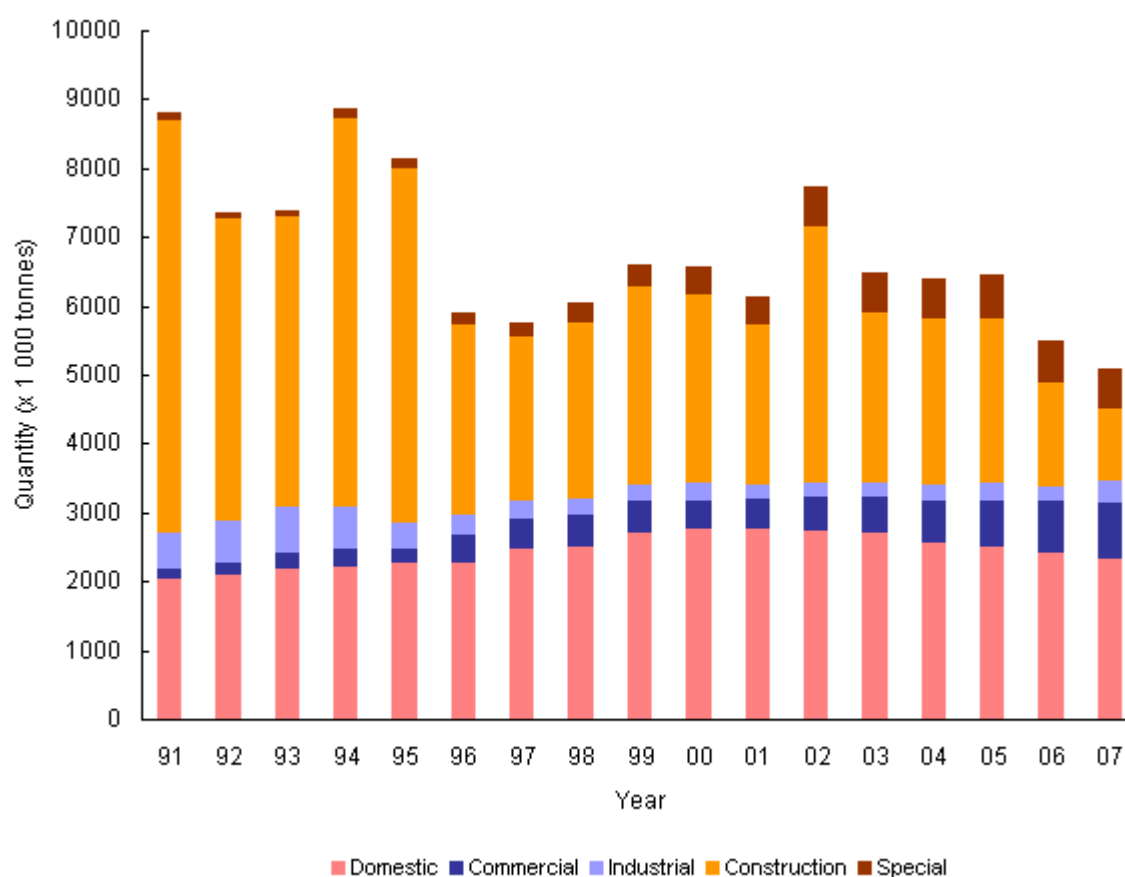
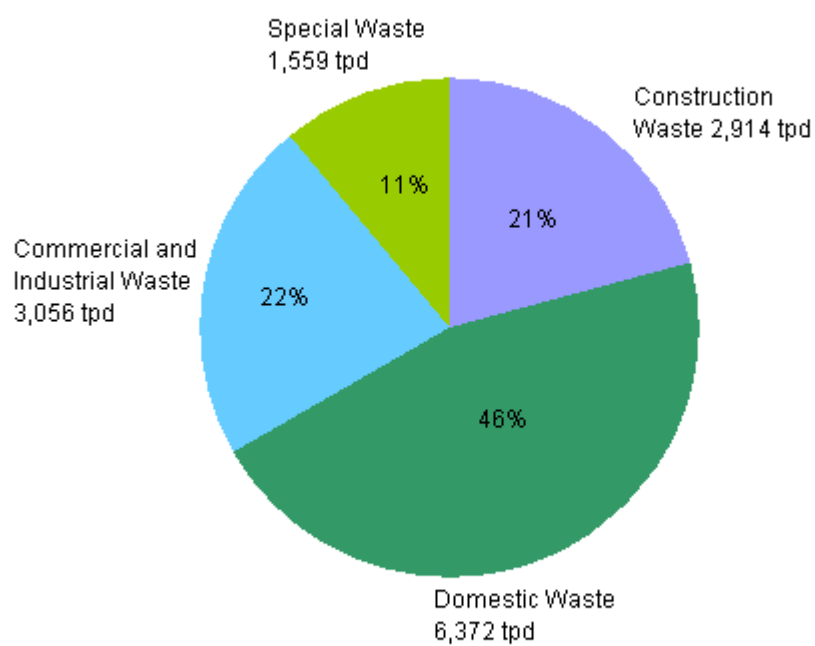


Figure - Types of Solid Waste Disposed of at Landfills in 2007



Total : 13,901 tonnes per day

Note : Figures may not add up to total due to rounding

Figure - Quantities of Construction Waste in 1991-2007

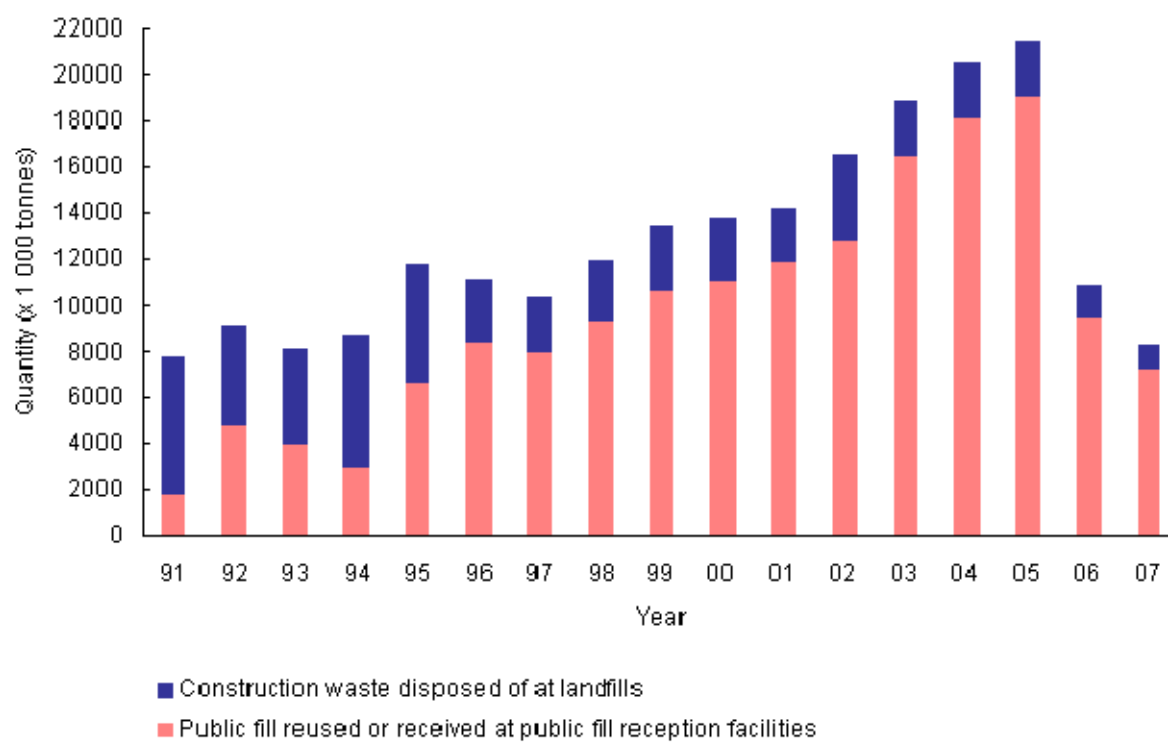
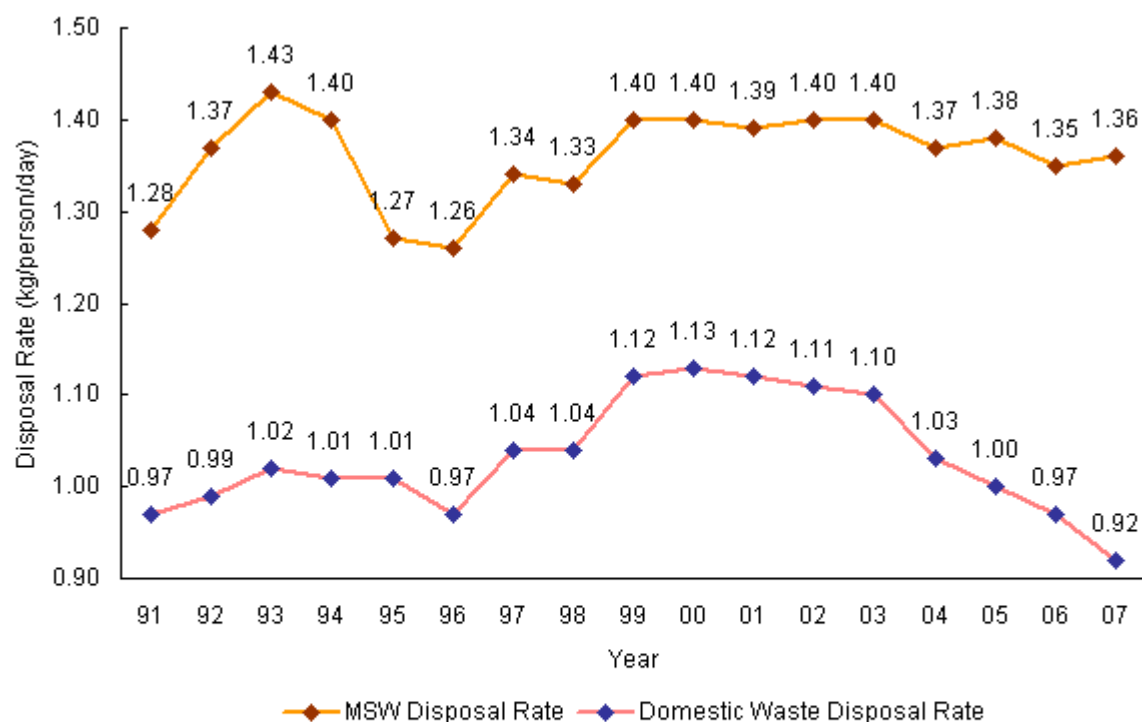
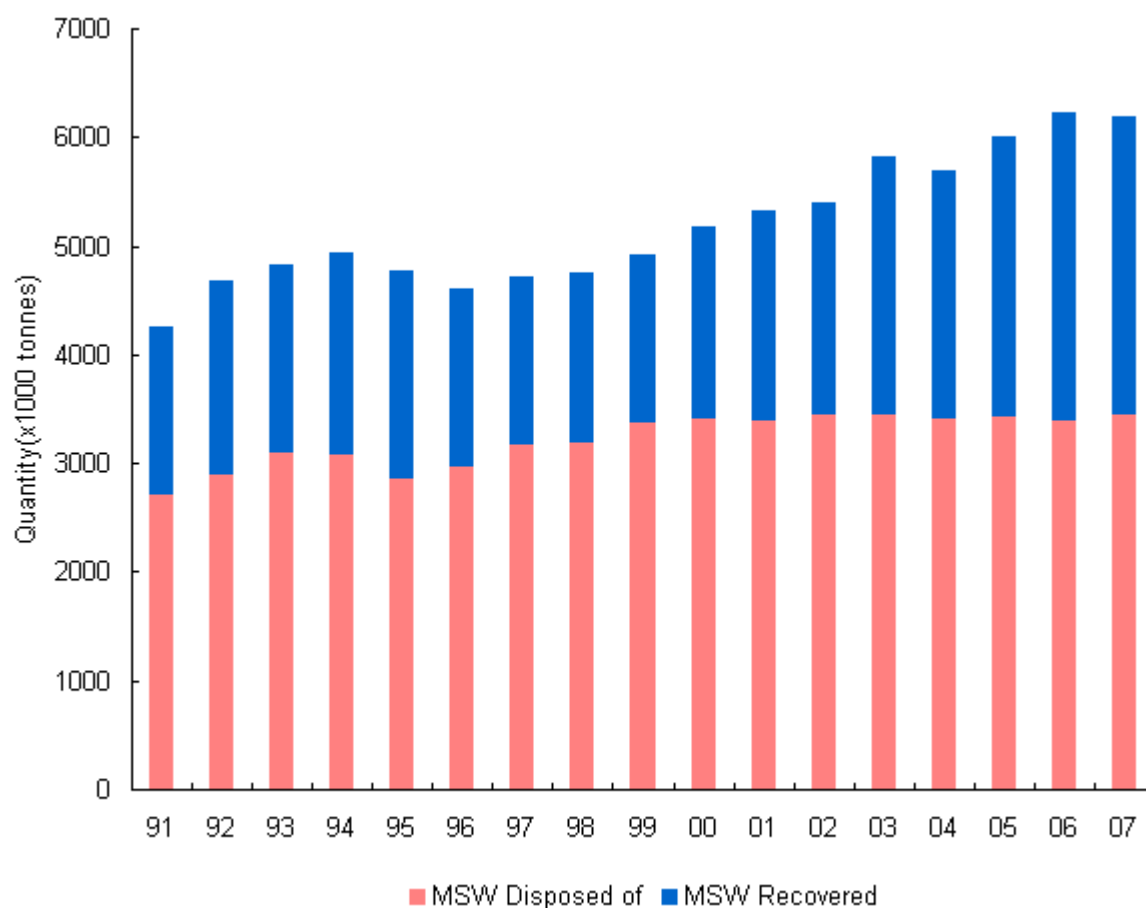


Figure - Per Capita Disposal Rates of Municipal Solid Waste & Domestic Waste in 1991-2007



Remark : Mid-year population figures are used in the calculation of per capita disposal rates. As the mid-year population figures from 2001 to 2005 have been revised in the 2006 Population By-Census, the per capita disposal rates reported in this table have been updated and differ slightly from the corresponding figures in previous reports.

Figure - Quantity of Municipal Solid Waste Disposed of and Recovered in 1991-2007



In addition, incinerating municipal and certain construction and demolition (C&D) wastes consume substantial energy and generates Dioxins, Furans and fly ash which are detrimental to both environment and public health. Thereby, reducing waste loads at source shall be the first priority for waste management, thereby extending the life of landfills. The sorting through the waste is typically 4Rs - reducing, reusing, repairing and recycling. EPD (2009) has launched several partnering programs e.g. Rechargeable Battery Recycling Programme, Computer Recycling Programme, Fluorescent Lamp Recycling Programme, Glass Container Recycling Programme, other Waste Reduction and Recycling Programmes e.g. Waste Electrical & Electronic Equipment Recycling Programme, District WEEE Recycling Days, Hong Kong Caritas Computer Recycle Project, Computer Printers, Scanners and Accessories (PSA) Collection, Reuse and Recycle Campaign, Source Separation of Domestic Waste, Separation of Commercial & Industrial Waste,

Lunar Year-end Recycling Campaign, Hong Kong Awards for Environmental Excellence-Wastewi\$e Label, Green Rural Waste Reduction Scheme; and a Waste Reduction Charter (Voluntary Agreement on Management of Mooncake Packaging). Major stakeholders like Facility Managers, owners' corporation, owners committee and mutual aid committee play an important role in managing and supervision these 4 Rs.

LITERATURE REVIEW

Kreith (2002) advocates that:

- the biggest step forward in finding solution to waste management problems is getting everyone to accept responsibility for ownership of the solid waste problem and its solution.
- the lack of facility sitting, more than anything else, is pushing us closer to widespread crisis that can easily breed panic solutions, guaranteed to fail in the long run.
- a successful solid waste program requires a focus on both planning and execution. Continuous program evaluation is important if the system is to function properly.
- the public and the private sectors have to win the confidence of the public back by insisting on first-rate environment protection. This can happen only through strong regulations and their deliberate enforcement.

Lund (2001) contends that all collection and processing methods are technologies that have their merits and limitation. There is no single answer or solution. Recycling, in whatever manner, is and must be part of integrated solid waste management strategies. When compared to the environmental risks associated with landfill or incineration, recycling is the preferred solid waste management strategy. IETC (1996) opines that both short-term and long-term plans can be oriented toward achieving results that can work within the given constraints. By explicitly considering resource constraints, planners can avoid the classic error of determining what should be, and instead concentrate on what is possible. Resources usually means money, but can also include expertise, authority, political clout, historic character, civic spirit, and other intangibles.

In order to develop a well-integrated and cost-effective MSWM system, planners must evaluate how well each potential piece of the system meshes with other existing or proposed system components. The fit of a particular component can be measured in terms of its purpose, size, location, ownership, operation, system of financing, and relationship to administrative and regulatory agencies. Specifically, individual components of the system should be:

- chosen so they do not overlap or compete excessively;

- sized so they can handle the portion of the waste stream they were designed for, without competing with other components;
- located so that transportation costs between management facilities are minimized and appropriate transportation networks are used;
- owned, operated, and financed to minimize overall public costs, while ensuring responsible management and cooperation with other system components;
- administered by appropriate agencies, with adequate public oversight.

The goal of a solid waste management plan is to change the behavior of those who generate waste so that they routinely transport, treat, and dispose of it in an environmentally safe manner (Probst and Beierle, 1999). Developing an effective waste management program typically requires the following steps (Beardsley, Freyberger and Kim, 2002):

- identification of the problem and enacting legislation;
- designation of a lead agency;
- promulgation of rules and regulations;
- development of treatment and disposal capacity;
- creation of a mature enforcement program.

The first step in developing a waste management program is identifying whether the present waste disposal practices are harming the environment and if so, then what legislation must be enacted to improve waste management.

To ensure that the appointed agency or agencies can solve and improve the current situation, at least four issues need to be addressed (Probst and Beierle, 1999):

- the agency must have the power to regulate.
- the agency's regulatory responsibilities must be clearly outlined with regard to how the responsibilities will be shared among national, state, and local authorities.
- it must be determined whether authority is solely possessed by one agency or distributed among agencies with a variety of responsibilities.
- such agencies must have sufficient financial, technical, and human resources to carry out their tasks.

Once laws are enacted to control waste management and an agency is appointed, regulations and requirements must be developed (Probst and Beierle, 1999). The first step in developing regulations

and requirements is to determine which wastes will be regulated. Which wastes are regulated depends greatly on the specific country.

The next step in implementing a waste management program is to develop enough disposal, treatment, and recycling facilities to handle the country's waste stream. This step does not necessarily occur sequentially with the other steps because building disposal, treatment, and recycling facilities takes time. Ideally, once regulations for waste management come into place there should be adequate capacity for the current stream of waste. If there is insufficient capacity to handle the waste, companies will not be able to meet the government's requirements. Unfortunately, waste facilities are costly to build and other factors, e.g. where the facilities are to be built, must be well thought out.

For the final step to be accomplished all the previously described steps must be achieved. A governing agency is in place, laws have been made, regulations have been implemented, and there is sufficient disposal/treatment/recycling capacity. In addition, to have an effective regulatory system there must be a "culture of compliance". If it is culturally accepted and expected to handle waste in an environmentally safe way, then companies will store, transport, treat, recycle, and dispose of their waste in a proper manner without the need for direct government involvement. In order for a regulatory program to have a culture of compliance, it must have enough public support so that companies comply. Public compliance with a regulatory program is usually achieved by making the threat of enforcement real. The success of a country's waste management system depends on a country's political and legal culture. With a successful program in place, it is possible to strive for the ideas of zero pollution and sustainable development.

Public education is a key part to the success of a recycling program. The government cannot monitor everyone to ensure that everything that could be recycled is being recycled. Thus, the public's view of recycling is important (Chan, 1998). In 1998, the Government unveiled the Waste Reduction Framework Plan (WRFP), which sets out the various initiatives for waste reduction. The WRFP is divided into three main program areas (ETWB, 1998):

- Prevention of Waste Program (to reduce waste being disposed of at landfills, increase waste to be recovered, recycled, and reused).
- Institutional Program (setting up a Waste Reduction Committee within the community, to coordinate waste reduction activities, propose waste reduction practices).
- Waste Bulk Reduction Program (to explore waste-to-energy incinerators and composting plants as another means to solve Hong Kong's waste problem).

The review in 2001 recommends a series of measures to facilitate domestic waste separation and recovery in Hong Kong; and sets the following targets: (i) to raise the overall MSW waste recovery rate from 34% to 36% in 2004 and 40% in 2007; (ii) to raise the domestic waste recovery rate from 8% to 14% in 2004 and 20% in 2007; and reduce C & D waste going to landfills by 25 % between 1999 and 2004. Through the existing waste recovery system, about 3.14 million tonnes of municipal solid waste were recovered in Hong Kong in 2008. Of that total, 1% was recycled locally and 99% was exported to the Mainland and other countries for recycling, with an export earning of HK\$7.4 billion for Hong Kong.

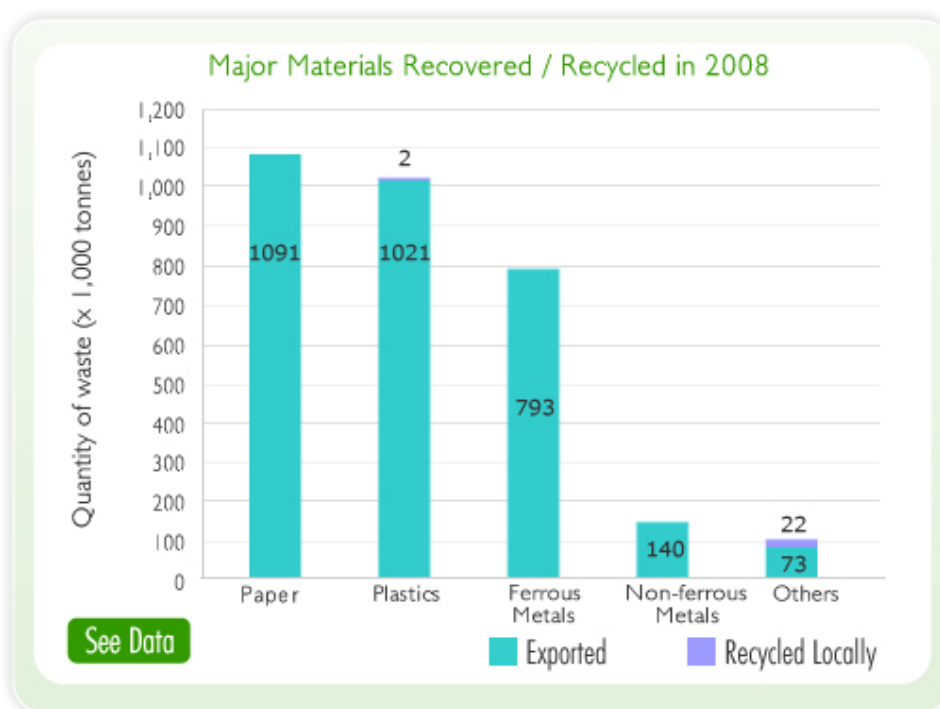


Figure - Major Materials Recovered / Recycled in 2008

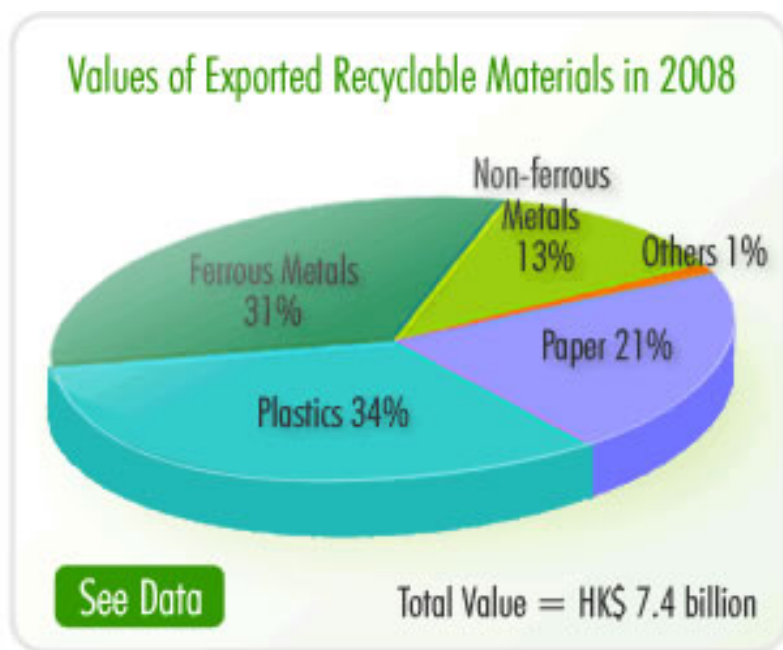


Figure - Values of Exported Recyclable Materials in 2008

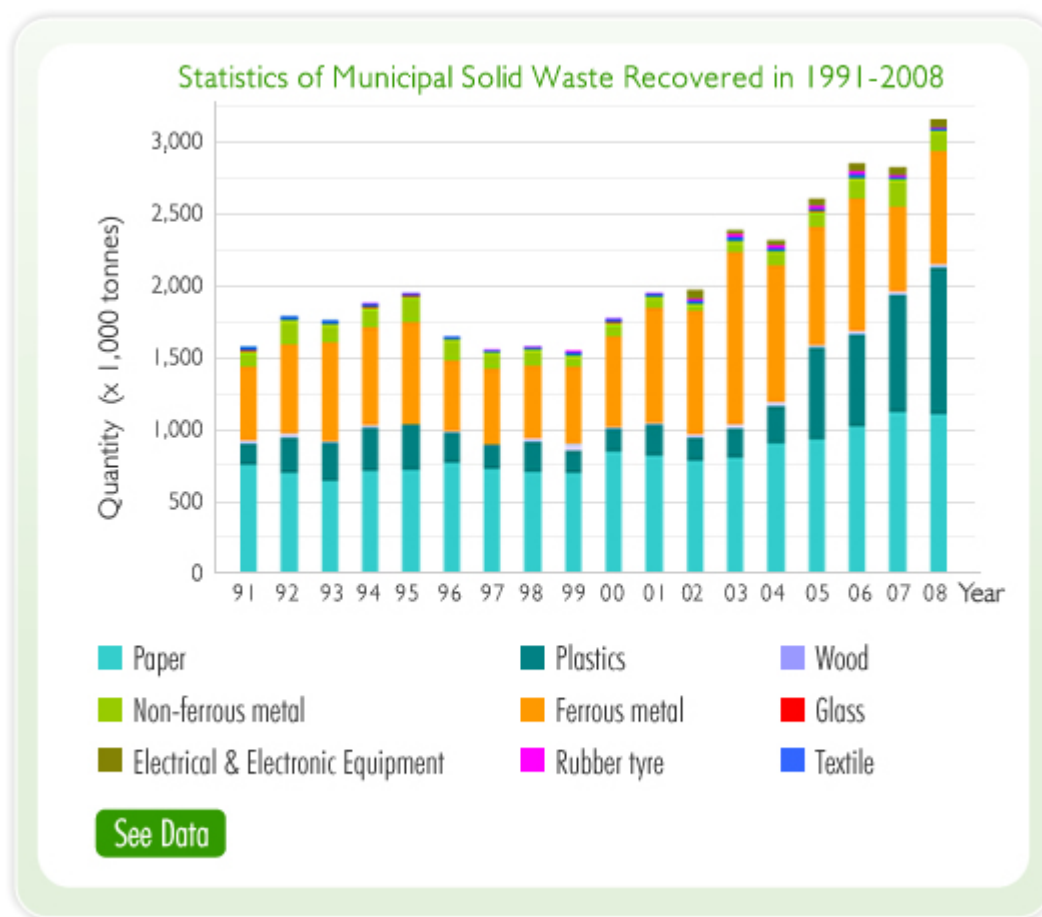


Figure – Statistics of MSW recovered in 1991-2008

Waste is also managed through legislations. The Waste Disposal Ordinance is used to enforce controls on waste disposal, including collection and disposal and the import and export of waste. The Dumping at Sea Ordinance is enforced to control disposal of dredged mud and excavated materials at designated marine disposal sites. Livestock Waste Control Scheme has been fully implemented in the management and disposal of livestock waste and also the Product Eco-responsibility Ordinance enacted in 2008.

Research Methodology

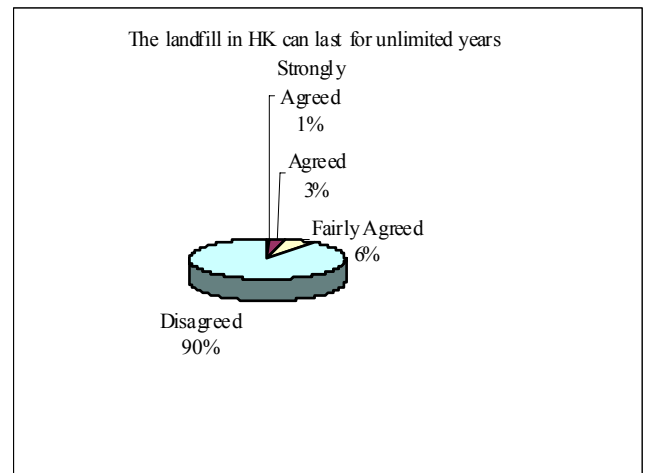
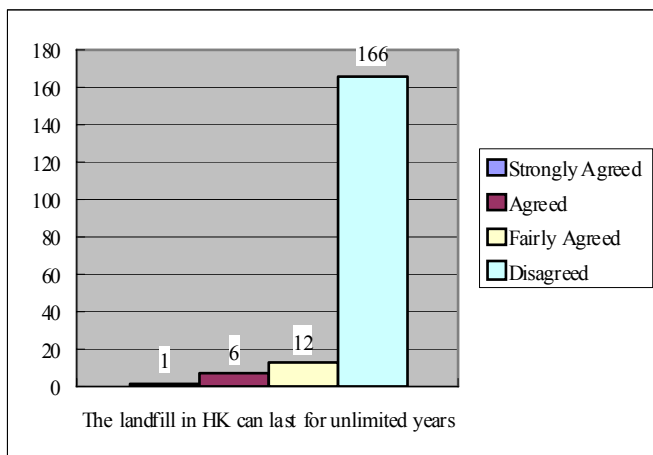
Quantitative approach with questionnaires are adopted and dispatched to residents of a large residential Estate M, with 18 questions in 5 sections as follow:

- Section A (Question 1 – 3 re. Limitation on landfills)
- Section B (Question 4 – 6 re. Reduction of landfill loadings via reducing solid waste)
- Section C (Question 7 – 9 re. Reduction of solid waste via effective Solid Waste Mgt.)

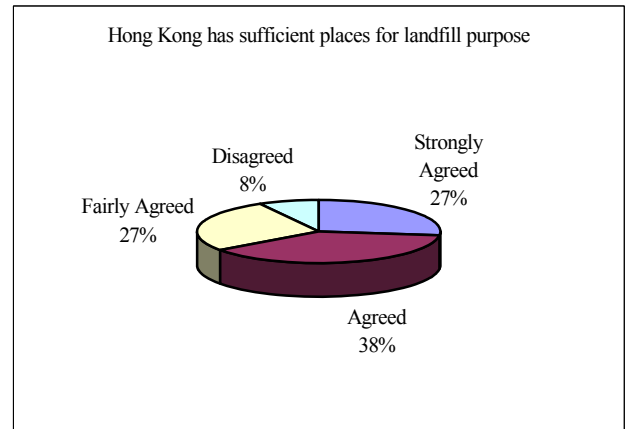
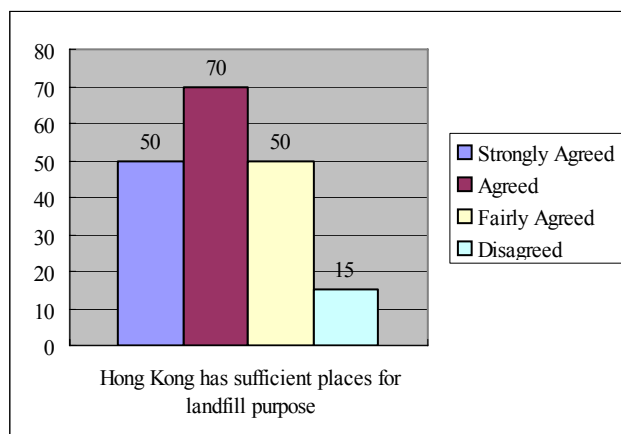
- Section D (Question 10 - 13 re. Benefits to estate and next generation via Solid Waste Mgt.)
- Section E (Question 14-18 re. Commitment to waste reduction, recycling & eco-activities)

185 out of 400 questionnaires (46% response) have been received, with results shown below:

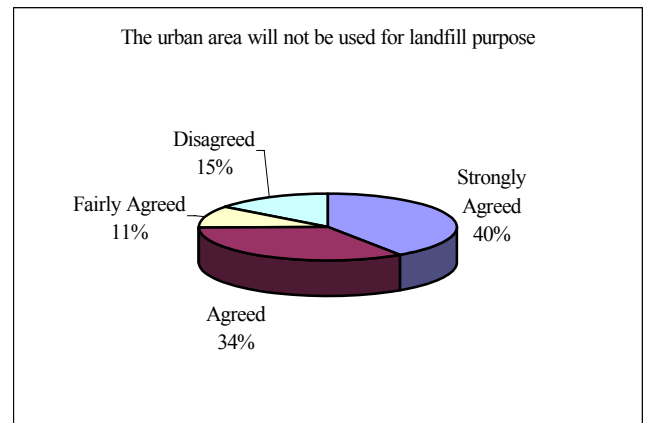
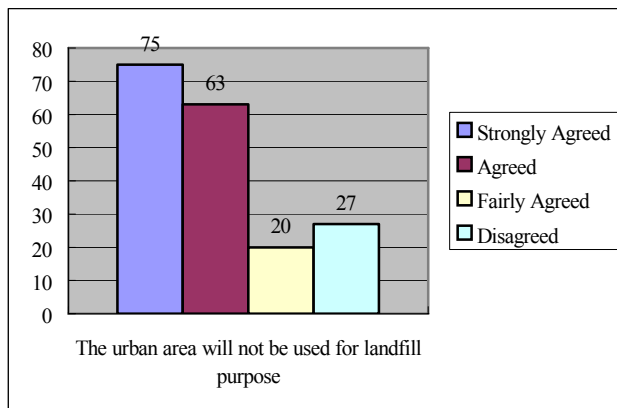
1. The landfill in HK can last for unlimited years.



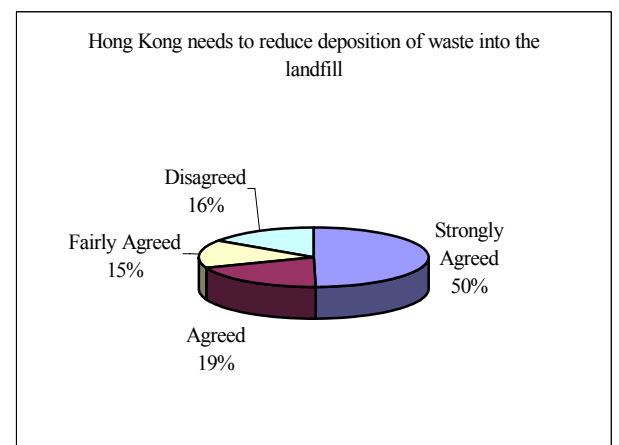
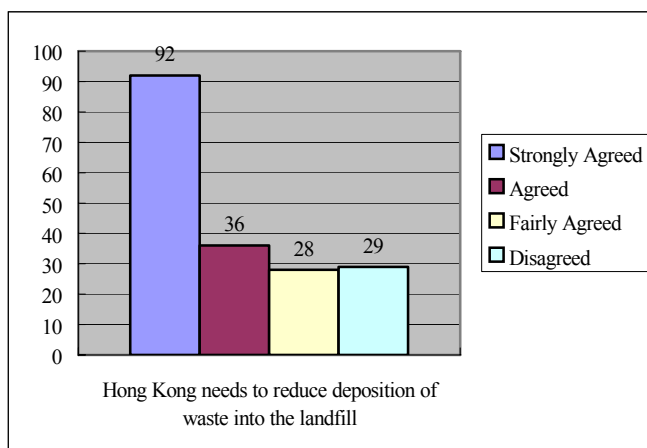
2. Hong Kong has sufficient places for landfill purpose.



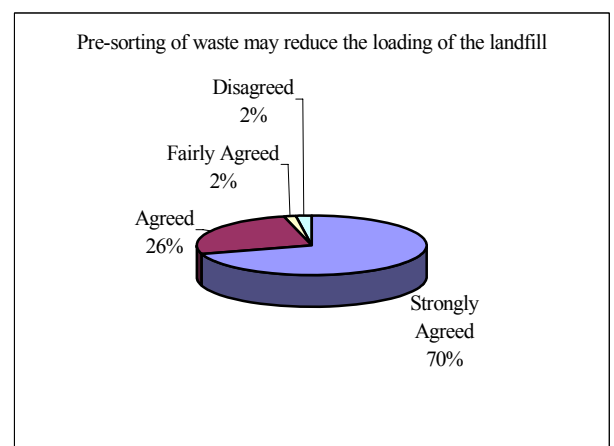
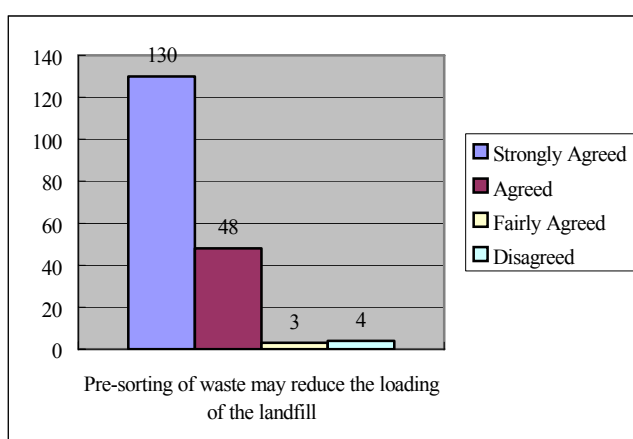
3. The urban area will not be used for landfill purpose.



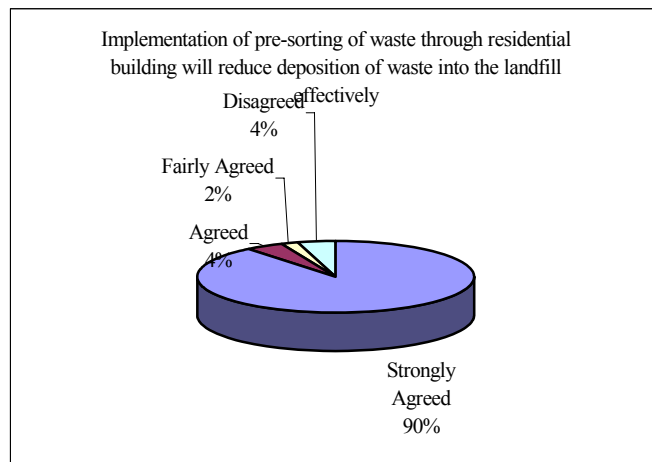
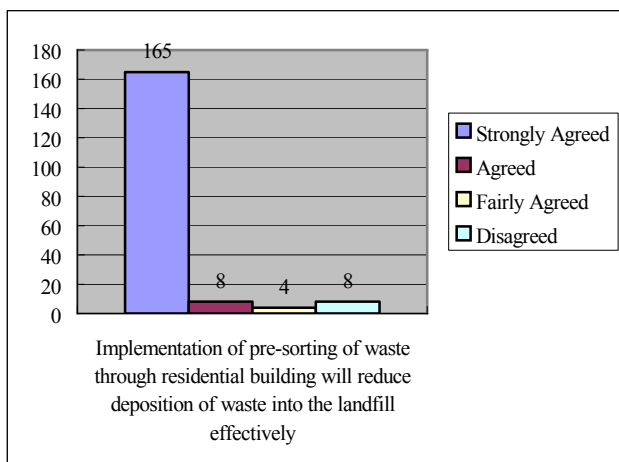
4. Hong Kong needs to reduce deposition of waste into the landfill.



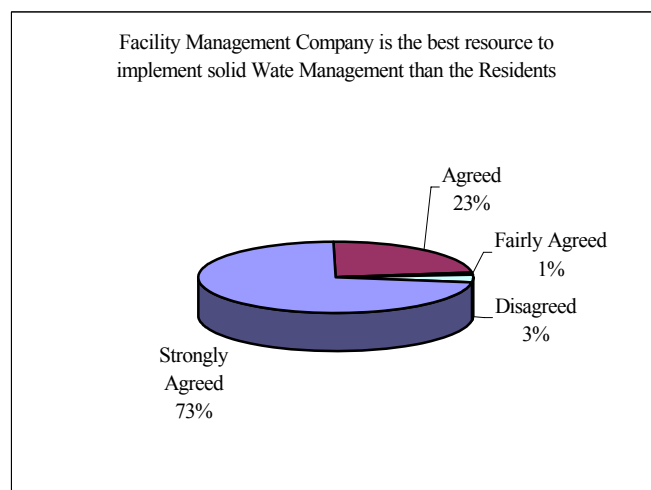
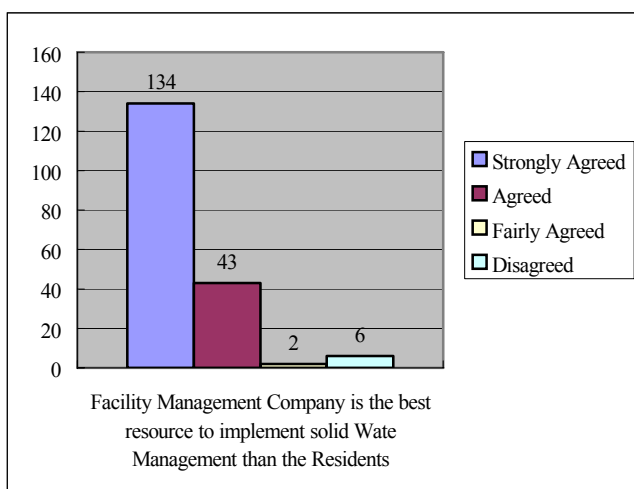
5. Pre-sorting of waste may reduce the loading of the landfill.



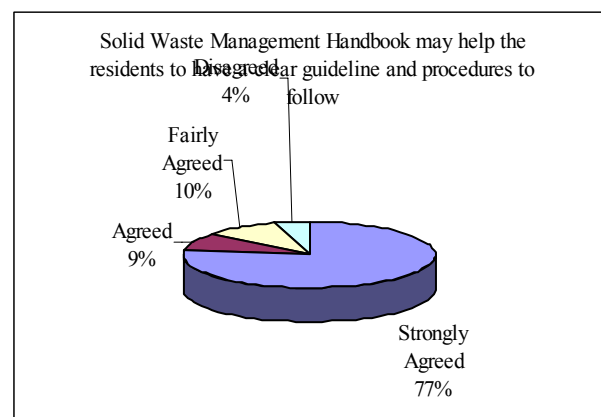
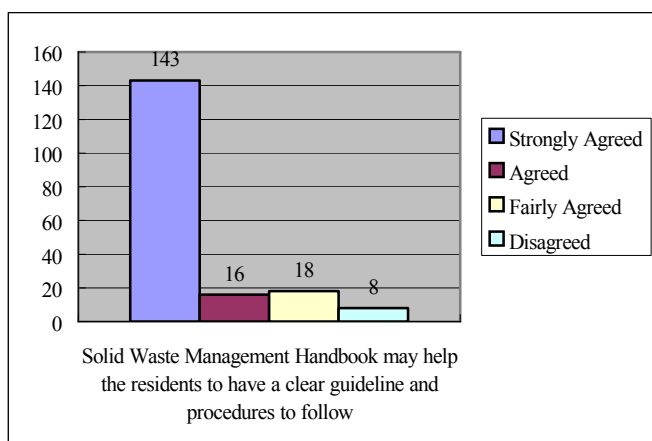
6. Implementation of pre-sorting of waste through residential building will reduce deposition of waste into the landfill effectively.



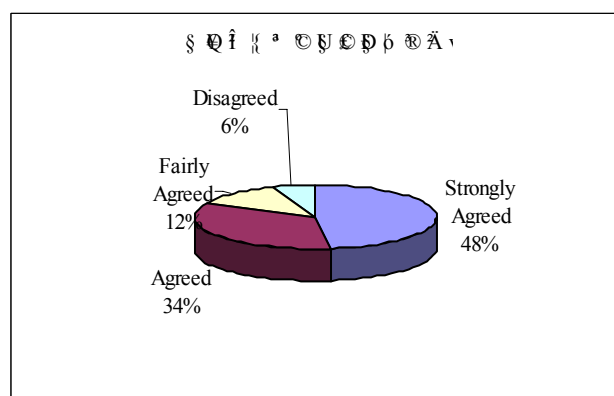
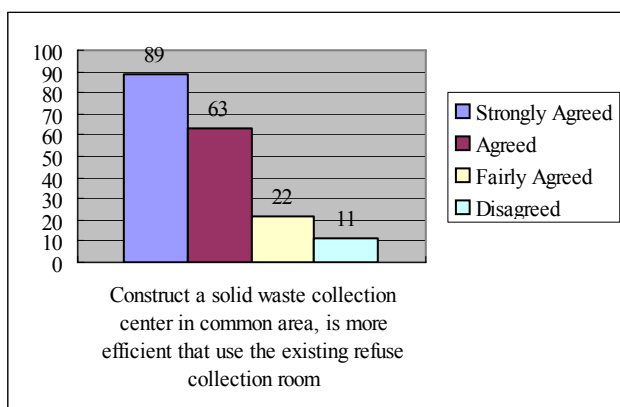
7. Facility Management Company is the best resource to implement solid waste management than the residents.



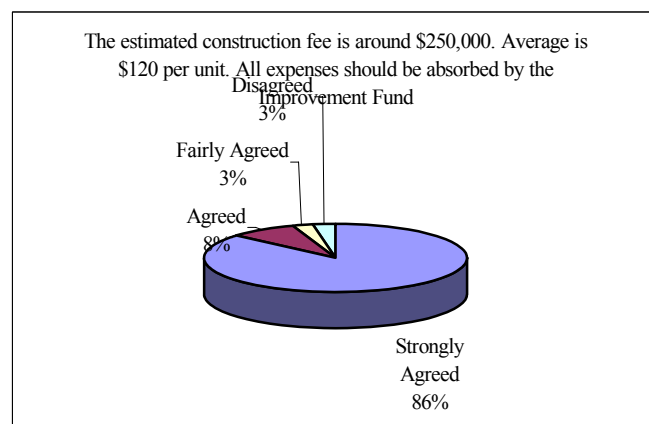
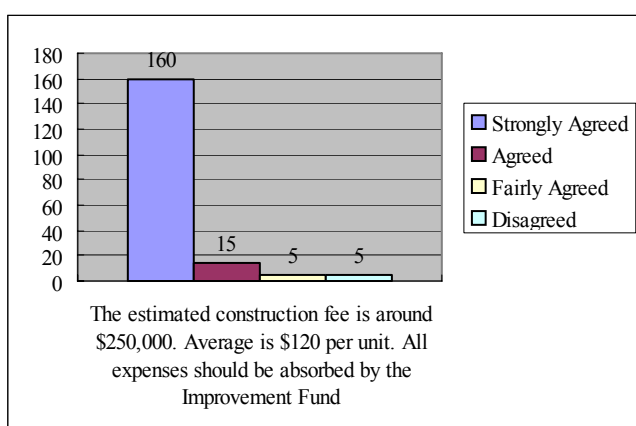
8. Solid Waste Management Handbook may help the residents to have a clear guideline and procedures to follow.



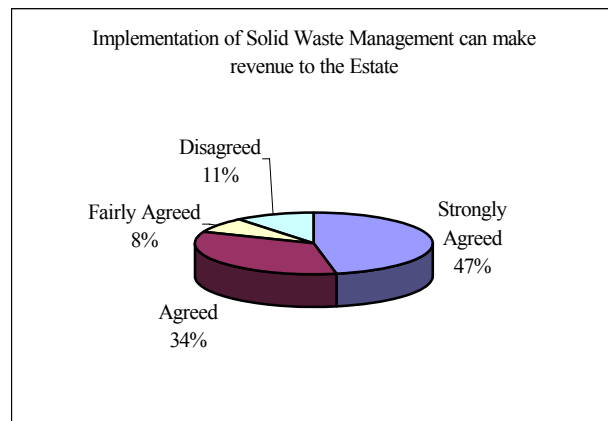
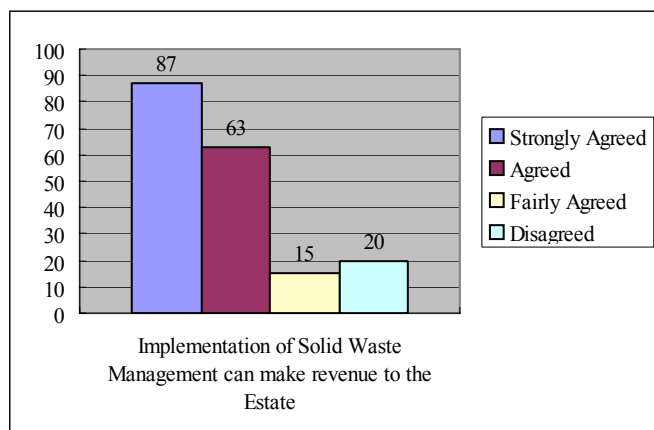
9. Constructing a solid waste collection centre in common area is more efficient than using the existing refuse collection room.



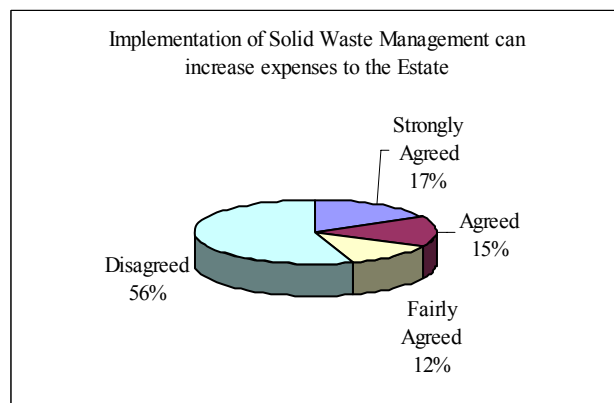
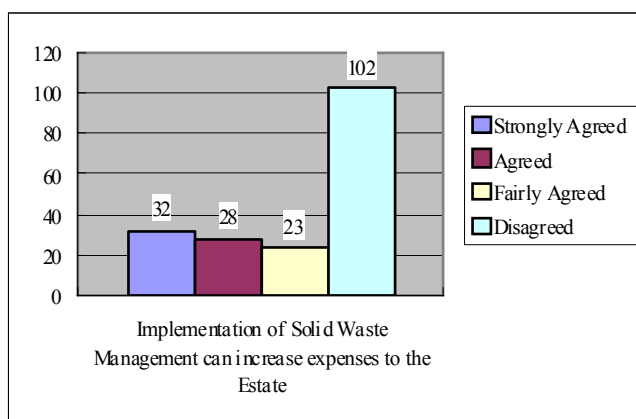
10. The estimated construction fee is around \$250,000, to be borne by all owners.



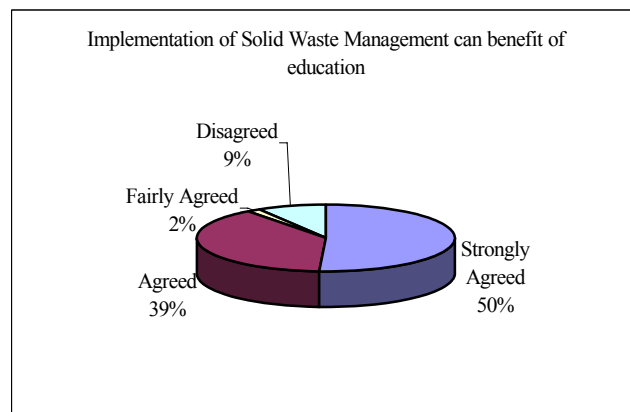
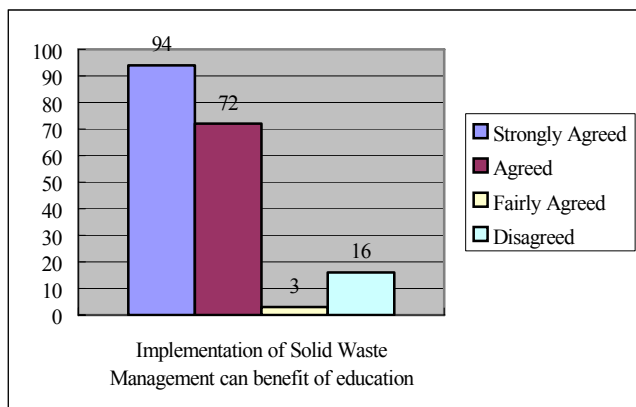
11. Implementation of Solid Waste Management will make revenue to the Estate.



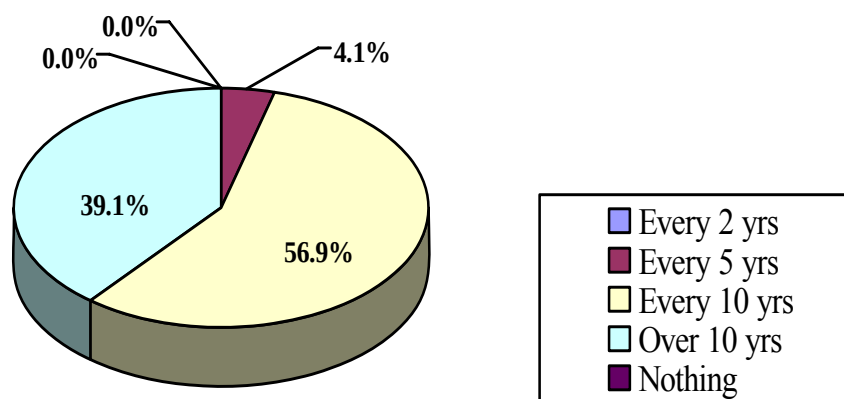
12. Implementation of Solid Waste Management will increase expenses to the Estate.



13. Implementation of Solid Waste Management can help educate the next generation.

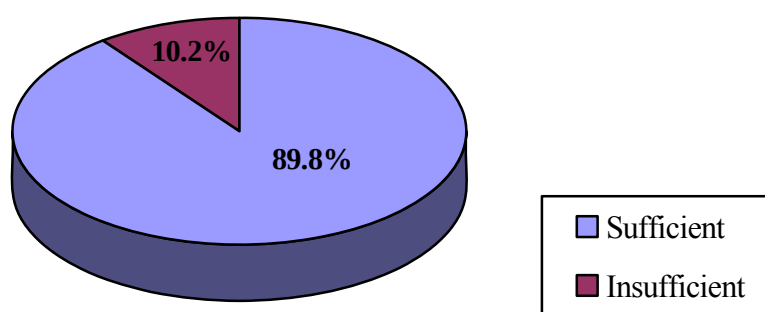


14. The residents will redecorate their home in _____ years.



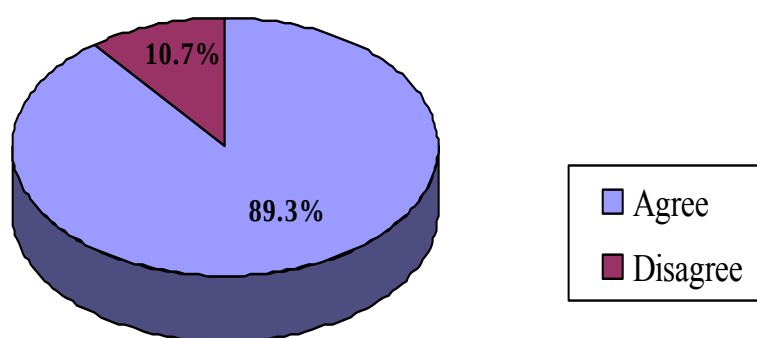
56.9% will redecorate once every 10 years, 39.1% in over 10 years, while 4.1% in 5 years. It appears that the majority would prefer not to create further C & D waste till after every 10 years (a longer cycle).

15. The existing 3-coloured recycle bins are adequately utilized.



89.8% opine adequate while 10.2% consider not.

16. The residents agree to incorporate “waste separation facilities” at typical floors.



89.3% agree to incorporate while 10.7% disagree, which reveals a high environmental awareness.

17. The residents will contribute the following materials for recycling:

Recycle materials	No. of family	Percentage
Old Clothes	183	98.9%
Battery/Cells	133	71.9%
Computer Disc (CD)	88	47.6%
Glass Containers	55	29.7%
Electrical Appliances	53	28.7%
Plastic Bag	48	25.9%
Food Waste	25	13.5%

It seems that residents have a higher preference to recycle old clothes, battery/cell, CD than others like glass containers, electrical appliances, plastic bags.

18. The residents will participate in the following eco-activities:

Eco-activities	No. of family	Percentage
Courses/workshops in reusing wastes	14	7.6%
Carnivals to raise awareness of environmental protection	43	23.2%
Regular collection programs launched by recycle contractors	65	35.1%
“Barter” exercise	79	42.7%
Donation of old clothes and toys to charity	86	46.5%
Will join other EPD programs if required	183	98.9%

It appears that donating clothes (without revenue) has higher priority than others like “barter” exercises; which demonstrates that most respondents generally accept and support the existing waste reduction measures and eco-activities; not necessarily relates directly with economic attainment.

The 5 sections of questions reveal the following:

- Section A – about 69% residents opine that Hong Kong’ landfill has its limitation; and that would trigger the desire to further reduce waste.
- Section B – about 87% residents agree that reduction of solid waste is required and presorting of solid waste can reduce landfill loading. They will presort the solid waste instead of dumping it entirely into the refuse chamber chute, provided sufficient solid waste separation containers are there.
- Section C – about 88% residents agree that Facility Management Company is the best stakeholder to implement Solid Waste Management. Most residents will participate, and set up a solid waste collection centre to handle the waste.
- Section D – about 83% residents believe that such plan will generate revenue and educate the next generation.
- Section E – the majority residents commit themselves to waste reduction, recycling, eco-activities etc.

CONCLUSION

The rapid growth of solid waste in Hong Kong has tremendous drawbacks upon the landfills and its life-cycle. 500 million tones landfill capacity would be required upto 2050. Without a consolidated waste reduction plan and commitment by “waste creators”, it’s quite difficult to resolve the problem entirely. This empirical study provides some initial highlights and knowledge about the ongoing issues; the success of which will be principally affected by consumers’ behaviour, economic situation, legislature, social awareness/conscious, facility management etc. A detailed tailor-made waste management plan per above studies would be suggested to further enhance the current waste reduction morale of the residents.

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