

STRUCTURAL OPTIMISATION APPROACH AND INDICATORS FOR
INTEGRATED MUNICIPAL SOLID WASTE MANAGEMENT

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Environmental Engineering)

Faculty of Chemical Engineering
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OCTOBER 2015

To my dearest husband, parents and family:
Whose love have nourished and sustained me always.

ACKNOWLEDGEMENTS

ABSTRACT

Rapid urbanization, population growth, and industrialization are contributing to the large-scale increase of total waste generation in Malaysia and changing the characteristics and composition of the municipal solid waste (MSW). The present practice of municipal solid waste management (MSWM) in Malaysia is depends very much on landfill disposal. To date, Malaysia is at the transition and planning stage towards sustainable MSWM with more efficient approaches. The main aim of this thesis is to develop a sustainable MSMW system based on a structural and comprehensive framework through optimisation modeling and indicator approaches. A case study of Iskandar Malaysia (IM) was employed in this research. In order to achieve the goal, three objectives were identified: the first objective is to evaluate and benchmark the performance of the MSWM system through a new developed indicator system known as Sustainable Waste Management Performance Indicator (SWMPI). The second objective is to assess the energy and carbon reduction potential of waste-to-energy (WTE) strategies for MSW in IM. The results in the second objective were used as the input data for the third objective. The third objective is to establish a sustainable and cost effective solution for the processing network of MSWM, through the model of Optimal Waste Processing Network (OWPN). At the end of the study, improvement of MSMW system through the third objective had been evaluated by the model of SWMPI from first objective. The analysis has proven that the optimal results from the OWPN model of MSWM system has successfully improved the waste management in terms of waste basic data, economic, waste management, and environmental criteria in SWMPI, where significant improvement was found in waste management and environment criteria of the indicator system. Both SWMPI and OWPN had been proven as powerful tools that assist the benchmarking of MSWM system in IM against other cities.

ABSTRAK

Proses pembandaran yang pesat, pertumbuhan penduduk, dan perindustrian telah menyumbang kepada peningkatan jumlah penjanaan sisa pepejal pada skala yang besar di Malaysia dan turut mengubah ciri-ciri dan komposisi sisa pepejal perbandaran yang dihasilkan. Pada masa kini, pengurusan sisa pepejal (MSWM), di Malaysia amat bergantung kepada tapak pelupusan sampah. Setakat ini, Malaysia berada pada peringkat peralihan dan perancangan ke arah MSWM yang mampan dengan pendekatan yang lebih berkesan. Tujuan utama tesis ini adalah untuk membangunkan satu sistem MSMW yang mampan dengan rangka kerja yang sistematik dan komprehensif melalui model pengoptimuman dan pendekatan indikator. Dalam penyelidikan ini, kajian kes Iskandar Malaysia (IM) telah digunakan. Untuk mencapai tujuan utama tesis ini, tiga objektif telah dikenal pasti: Objektif pertama adalah untuk menilai aras prestasi sistem MSWM melalui sistem petunjuk baru yang dikenali sebagai Petunjuk Prestasi Pengurusan Sisa Pepejal Mampan (SWMPI). Objektif kedua adalah menilai potensi tenaga dan pengurangan karbon daripada sisa pepejal melalui strategi Sisa ke Tenaga (WTE) dalam IM. Keputusan daripada objektif kedua telah digunakan sebagai input untuk objektif ketiga. Objektif ketiga adalah untuk memberikan satu penyelesaian jangka panjang dan kos efektif untuk rangkaian pemprosesan MSWM, melalui model Rangkaian Pemprosesan Sisa Optimum (OWPN). Pada akhir kajian ini, peningkatan MSMW melalui objektif ketiga akan dinilai melalui model SWMPI daripada objektif pertama. Analisis ini membuktikan bahawa hasil yang optimum daripada model OWPN sistem MSWM telah berjaya memperbaiki pengurusan sisa dari segi data asas, ekonomi, pengurusan sisa dan kriteria alam sekitar di SWMPI, di mana peningkatan yang mendadak telah dilihat dalam pengurusan dan persekitaran sistem petunjuk. Kedua-dua model SWMPI dan OWPN telah dibuktikan sebagai alat yang berkuasa memberikan penanda aras untuk sistem MSWM di IM berbanding dengan bandar yang lain.