CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

According to the main findings of this research, semi-aerobic sanitary landfill model is a good option for developing nations particularly Malaysia. Based on the economic evaluation (cost-benefit analysis), both FM landfill system (Landfill A) and reformative landfill (Landfill B) can achieve economically efficiency point after certain period of time. Yet the calculations and estimations from construction to final closure can be rectified with actual data.

Landfill A is chosen as a good example of effective landfill. The study of structure and construction environment shows that this type of landfill is suitable to be applied in developing countries. Within 20 operational years, Landfill A with FM concept can receive 3,471,137 tonnes of waste and it is estimated to spend RM 127,720,897 and gain a direct benefit of RM 128,541,520. Averagely, to dispose 1 tonne of waste, it will cost around RM 36.4 per tonne and the economically benefit will be RM 37 per tonne. According to the cost-benefit analysis, this landfill can achieve economical efficiency point after 15 operational years. Because FM landfill is famous for its low cost and low technology, the benefits always exceeds costs before the efficiency point (including construction costs and operational costs). However, after 16 years, the capacity of

Landfill A is close to the full-load that the efficiency will decrease. Therefore, it is recommended that an early-closure can be arranged for Landfill A.

Landfill B is chosen as an operational local landfill, which is a partial semi-aerobic sanitary landfill. It is designed to receive around 8 million tonnes of waste within 16 years. However, due to the rapid growth rate of waste generation, Landfill B life span has been cut to 8 years. Landfill B has total direct investment of RM 97,774,516 and it is estimated to gain RM188, 307,506 within the reality operational period. Landfill B can achieve the economical efficiency point after five operational years. Landfill B has a higher initial costs compared with Landfill A, in the first five years, the benefits is under the costs in Landfill B. The operating costs of Landfill A is slightly less than that in Landfill B, and it is important that Landfill B will start to use the landfill gases to generate electricity for internal usage in the end of 2012. The introducing of new technology highly improves the efficiency and reduces the operating cost in Landfill B system. At the same time, the bio-gases power generators can assume the landfill gases emissions which decrease the environmental impacts.

According to the cost-benefit analyse results, the Landfill B is more effective compared with Landfill A. Therefore, adjustments of semi-aerobic sanitary landfill concepts are necessary. Landfill B has a stronger competition in the market. However, because of its high initial costs, Landfill B is not suitable to be developed for long-term operation.

6.2 Recommendations

This research shows the environmental economic evaluation is a useful and applicable tool for choosing the technologies based on the local situation. It also has the potential to be applied in decision-making of environmental policy. The future research can be conducted to find out the alternatives indicators as well as solutions.

New technologies, such as waste-to-energy concepts in the usage of incineration, are recommended to be introduced in the MSW management system. It is expected that 80% of waste disposed by these incinerators. Bio-gases power generation technology can consume methane 40% of landfill gases are methane, which has more global warming impacts compared with carbon dioxide to decrease the risks to environment and public health and create benefits to landfill. Landfill B is scheduled to start the bio-gases power generation in 2012, and this will be an opportunity for further research about the efficiency improvement.

It is found that open-dumps still occupies a large percentage in the waste disposal system in Malaysia. FM landfill system is proved as a proper option to convert open dumping sites to sanitary landfills. In a long-term operation, FM landfill can improve the efficiency of the entire waste management system in a proper approach.

It is suggested to develop recycling programmes, which will reduce the amount of waste disposed to landfills, thus extending the life span of sanitary landfills. Private companies should be encouraged to be involved in the development of recycling projects.

As a tropical developing nation, Malaysia needs an integrated MSW management system for sustainable development. Improving and developing solid waste disposal system is not the only approach. Effective public participation can enhance the efficiency of current waste management system. It is necessary to develop appropriate procedures and guidelines for public participation and corporation. Proper waste and environmental education in schools, universities and communities will contribute to minimize the amount of waste generated and reduce the risks to human health, due to public awareness.