CHAPTER 5

SUSTAINABILITY ASSESSMENT OF EXISTING MSW MANAGEMENT SYSTEM IN THAILAND

5.1 Existing MSW Management System in Thailand

Prior to making any decision on replacing the present systems or implementing new MSW management systems, it is necessary to do a detailed evaluation of the existing status of MSW disposal methods in an appropriate way. Therefore, the sustainability of existing MSW management methods were evaluated for a representative location by using developed indicators. According to PCD, 22 % of generated waste is being recycled in Thailand (PCD, 2009b) and the remaining fraction is disposed at sanitary landfills and open dumps. As reported, during the past decades, there has been a gradual improvement in waste disposal practice from open dumping to sanitary landfilling (Chiemchaisri et al., 2007). Based on PCD (2009b) study, the fraction of waste being disposed at sanitary landfills and open dumpsites was found to be 47% and 53%, respectively. According to this trend, sanitary landfilling will become the most prominent MSW management method in Thailand in next few years. Therefore, to evaluate the sustainability of the mostly practicing two major MSW management methods in Thailand, such as recycling and sanitary landfilling, "Nonthaburi Municipality" was selected as the suitable study location by targeting to acquire the accurate data related to above two technologies.

5.2 Existing MSW Management System in Nonthaburi Municipality

Nonthaburi municipality is located 20 km northwest of Bangkok. This Municipality is situated in Muang District, Nonthaburi Province. The Municipality covers an area of 39 km^2 hosting a population of 0.27 million, and the population distribution is 6862 persons/km^2 (Nonthaburi Municipality, 2009). The climate of Nonthaburi Municipality is a semi-humid, monsoon tropical type, with a rainy season that lasts from May to September with temperatures 25-41 ^{0}C.

At present, Nonthaburi municipality is making a significant effort on maximizing recycling and minimizing waste under the Kitakyushu Initiative Network Program to develop an effective MSW management progamme through community approaches, public awareness and public participation. They have set the policies to promote waste segregation at source through public participation. As a result, 22% of waste recycling rate in the year 2006 has risen to almost 25% in 2010. Public participation and awareness building were deemed as the key features for the successful achievements as well as the strong political will of the local administration (Nonthaburi Municipality, 2009).

5.2.1 Overview of recycling activities in Nonthaburi

At present, the average amount of MSW generation in Nonthaburi municipality is 370 tonnes per day, with a MSW generation rate of 0.8 kg per capita per day. About 90 tonnes of point source separated waste is being recycled and 38 small companies are involved in collecting those recyclables. The collected recyclables consist of five major categories such as paper, plastic, glass, aluminum and steel and it amounts to 22.92%, 3.29%, 7.31%, 26.58%, and 39.89 % respectively. These recyclables are pre-processed at the sorting facility and then send to various recycling facilities in different provinces (Nonthaburi Municipality, 2010).

5.2.2 Overview of sanitary landfill in Nonthaburi

The remaining 280 tonnes of generated MSW is being collected by Nonthaburi Municipality by using 45 compactor trucks. It should be noted that Nonthaburi Municipality has introduced modern waste management technologies to their waste collection system which cannot be observed in most of developing Asian countries. In the year 2005, Nonthaburi municipality upgraded its waste management system by applying Vehicles Monitoring System (VMS) to waste collection trucks so that municipal administration can continuously monitor the location of their collection vehicles via GPS. Thus, this system provides greater efficiency in waste collection service reduces the risk of accidents and lower the operating cost (Nonthaburi Municipality, 2009).

After the collection and transportation, all the collected waste is disposed in the Nonthaburi landfill which is situated 50 km away from the municipality. The capacity of the Nonthaburi landfill is 900 tonnes per day and waste comes not only from Nonthaburi Municipality but also from 11 other municipalities, 30 urban councils and 19 companies within the Nonthaburi province. Presently operating landfill area is extended to 16.1 ha and its designed depth is 12m with a waste density of 850kg/m^3. High Density Polyethylene (HDPE) liner is used at the bottom of landfill to avoid contamination of leachate with the ground water table. After filling up to the designed capacity of the landfill, it is covered with a 1-2 m high soil layer and planted with some trees. There is a leachate pond for collecting leachate which is extended to an area of 100 rai. Rivers osmosis system is being used as the leachate treatment method and the leachate treatment facility has been designed for treating 1000 m^3 of leachate/day. As of today, there is no landfill gas collection system, so that there is a potential of emitting significant amount of methane to the environment.

5.3 Sustainability Assessment of the Existing MSW Management System

5.3.1 Defining the LCA framework for sustainability assessment

Life cycle framework is designed for the existing MSW management system in a systematic way for sustainability assessment considering all the phases of the life cycle. For instance, recycling process includes collection and transportation, pre-processing at the sorting facility, transportation of pre-processed recyclables to the recycling facilities by heavy duty trucks and recycling processes of different type of recyclables at various recycling facilities. The system boundary of the sanitary landfill includes collection and transportation of MSW by compactor trucks, final disposal at sanitary landfill and leachate treatment. The schematic diagram of the LCA framework of the existing MSW management system in Nonthaburi is shown in Figure 5.1 where all the required inputs and outputs categories have been included for sustainability assessment.

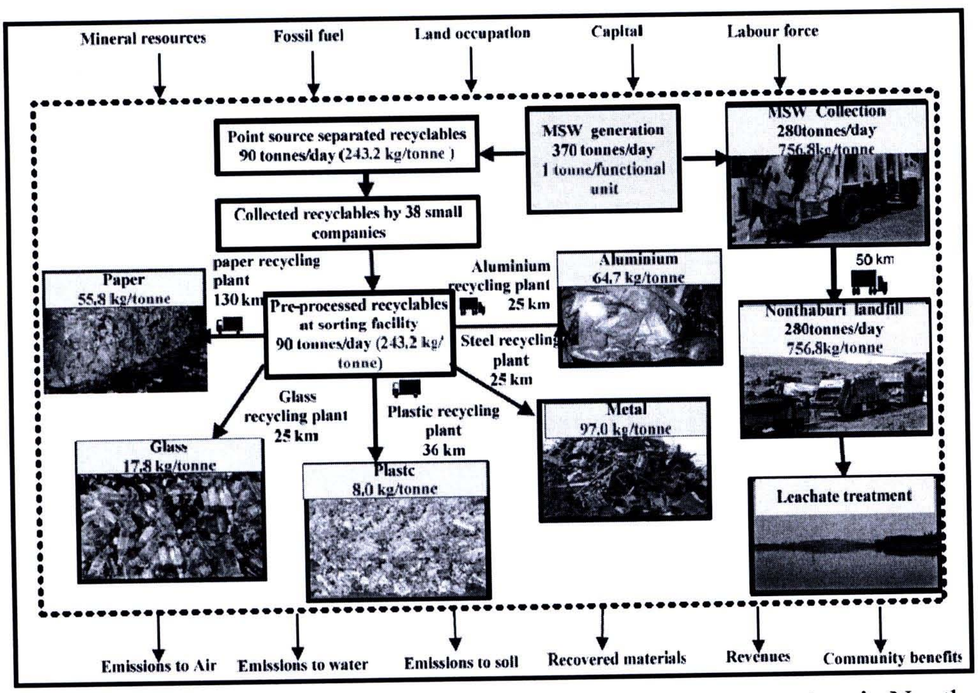


Figure 5.1: LCA framework of the existing MSW management system in Nonthaburi

5.3.2 Inventory analysis of the existing MSW management system

In this step of sustainability assessment, an inventory analysis was done in relation to the environmental, economic and social aspects. As shown in Figure 5.1, all the input resources and energy production processes and its emissions were taken into account for the entire life cycle of both recycling and landfilling. Eco-invent and BUWAL 250 databases were used to estimate the material consumption and emissions for recycling and virgin production processes (Hischier and St. Gallen, 2007; Pré Consultants, 2007b). Appendix A1 describes in detail, different types of waste recycling processes and the inventory analysis of recycling as well as virgin production. It should be noted that in the inventory analysis, materials recovered from recycling were credited for avoidance of virgin production processes.

Various data sources were used to do the inventory analysis of landfill. Appendix A1 shows the required data and the inventory analysis results related to resource consumption and emissions of the presently operating sanitary landfill in Nonthaburi. In addition, all the required information related to economic and social LCA assessment of both recycling and landfilling were collected from various recycling plants in Thailand and Nonthaburi Municipality with support from the managerial team.

5.4 Results and Discussions

As discussed in Chapter 4, the most relevant midpoint indicators can be used to assess the sustainability and it would be useful for the scientific decision making process. Appendix A, shows the LCA results using commonly used and relevant midpoint indicators. However, in this chapter, the major focus is to provide a more comprehensive three-dimensional sustainability assessment using the endpoint composite indicators developed in this research work.

5.4.1 Environmental sustainability assessment of the existing MSW managmenet system

Quantification of "damage to ecosystems"

There are two major ways of damaging the ecosystems from the MSW management practiced at present. First, from acidifying and eutrophying substances that are emitted during degradation process of MSW in landfill and from the energy and raw materials production for both landfilling and recycling can cause damage to ecosystems. Second from the occupancy of land directly (landfilling) or indirectly (fossil fuel mining). It causes changes in land use types due to conversion of lands (to quantify the damage, the methodology explained in Section 4.1 was used).

For instance, Nonthaburi landfill occupies marginal crop land for the landfill and the PDF of marginal land occupation is 1.19. It can reach the value of 0.47 after the considerable restoration period, during which some coniferous plant species are grown (Goedkoop et al., 2008). In addition, a major damage to ecosystems is caused by the energy consumption of MSW management systems. As reported, PDF of occupied fossil fuel mining land is 1.19 and the damage caused due to the occupation of mining land is also accounted. However, land occupation for recycling activities was considered negligible since the process is quite fast and land occupation time is negligible.

In order to convert the direct land occupation of landfill to global bio-productive area, it was assumed that the landfill is situated in a marginal land so that equivalency factor was 1.8 global ha/ha (Wackernagel et al., 2005) and yield factor of marginal crop land in Thailand is 2 relative to the yield of world average marginal crop lands. Giving consideration to all those factors, ecosystems damage due to emissions and land occupations of existing MSW were calculated for landfilling and recycling processes see Table 5.1.

Table 5.1: Quantified damage to ecosystems ($PDF.m^2_{global}.yr$) from landfilling and recycling

Factors of damage to ecosystems	Landfilling (per tonne mix waste)	Damage from recycling per tonne of recyclables					
		Paper	Plastic	Glass	Aluminium	Metal	Recyclable mix (per tonne)
Damage to ecosystem from acidifying and euthophying substances	5.78E+02	7.12E+01	1.73E+02	6.21E+01	1.55E+01	6.00E+01	5.46E+01
Damage to ecosystem due to direct land occupation	1.06E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Damage to ecosystem by mining of fossil fuel	2.96E+02	1.58E+04	3.84E+04	1.20E+04	5.47E+03	1.21E+04	1.20E+04
Total gross damage to eco-system	**8.84E+02**	**1.58E+04**	**3.85E+04**	**1.21E+04**	**5.49E+03**	**1.21E+04**	**1.21E+04**
Credited damage for valuable by-products (recovered materials)	0.00E+00	1.45E+04	7.29E+04	1.68E+04	1.67E+05	3.33E+04	6.46E+04
Net damage to ecosystem	**8.84E+02**	**1.38E+03**	**-3.44E+04**	**-4.74E+03**	**-1.61E+05**	**-2.12E+04**	**-5.25E+04**

It is noteworthy to mention that as far as landfilling is concerned, 65% of gross ecosystem damage occurs from the emission of acidifying/eutrophying substances while the remaining 35% of ecosystem damage occur from direct and indirect land occupation. In relation to recycling, 99% of gross ecosystem damage occurs from land occupation for mining of fossil fuel for recycling activities see Table 5.1.

The quantified net ecosystem damage per tonne of mix wastes landfilling and per tonne of mix recyclables recycling are 8.84E+02 and -5.25E+04 $PDF.m^2_{global}.yr$ respectively. Recycling results in net negative damage to ecosystem, since material recovered from the recycling processes has been credited for avoidance of the virgin production process chain. It is noticeable that when compared to other types of recyclables, aluminium recycling has the highest ecosystems protection potential. The reason is that virgin aluminium production process consumes a massive amount of electricity and thermal energy and it causes damage to the ecosystems considerably which can be avoided by the process of aluminium recycling.

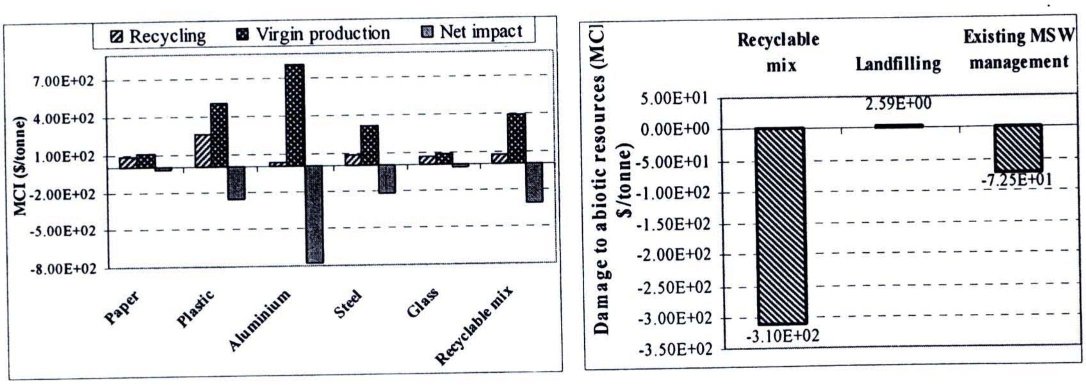
It is important to know that the overall ecosystems damage occurs from the existing MSW management system in the Nonthaburi where 76% of waste goes for landfilling and the remaining 24% of waste is being recycled. This can be calculated as follow;
Net damage to ecosystem from the existing MSW management system (per tonne of waste) = net damage to ecosystem from landfilling per tonne × 76/100 + net damage to ecosystem from recycling per tonne × 24/100 = -1.19 E+04 $PDF.m^2_{global}.yr$ per tonne.

Even though, landfilling causes some damage to ecosystems, its ultimate effect can be neutralized by the potential avoidance of damage from the materials recovered as a result of recycling. The ultimate result gives a net negative value as the overall ecosystems damage per tonne of generated waste management in Nonthaburi. This is a very good indication of the sustainability of ecosystems. Even though only 24% of waste is recycled, it contributes substantial avoidance of damage to ecosystems which is far above the damage caused to ecosystems from both landfilling and recycling.

-Quantification of "damage to abiotic resources"

Damage to abiotic resources due to fossil fuel and mineral utilization from existing MSW management activities in Nonthaburi can be considered as one of the major damages to the environment. In order to measure the potential damage caused by energy and mineral consumption, the methodology explained in Section 4.1.2.2 (quantification of damage to abiotic resources) was used. According to the analysis results, it was noted that the recycling process has a significant influence on the avoidance of damage to abiotic resources that would have otherwise occurred from virgin production processes see Figure 5.2a. As a result of credited impacts due to material recovery from recycling and avoided virgin production, net negative damages from all types of recyclables are observed as shown in Figure 5.2a.

It is noticeable that the landfill presently in operation is creating some damages due to abiotic resources depletion (see Figure 5.2b.), since a significant amount of fuel is required for the transportation of waste and compaction of waste at the landfill (6.47 L diesel required per tonne of waste). In addition, fossil resources are required for HDPE liner manufacturing process. In return, there is no contribution to save abiotic resources from the existing landfill. As of today, there is no incorporated landfill gas collection system for extracting energy. In contrast, the current recycling activities would substantially contribute to avoidance of abiotic resources depletion through material recovery and the estimated net savings would amount to \$310 per tonne of mix recyclables (see Figure 5.2b).



(a) (b)

Figure 5.2: (a) Damage to abiotic resources per tonne of waste recycling, (b) Damage to abiotic resources from the existing MSW management system in Nonthaburi.

Net damage to abiotic resources from the existing MSW management (per tonne of waste) = Net damage to abiotic resource from landfilling per tonne × 76/100 + Net damage to abiotic resource from recycling per tonne × 24/100 = -$72.5 per tonne.

24% generated waste recycling in Nonthaburi, has made a tremendous impact on the outcome of the entire MSW management system. It can be noticed as a net negative damage value of abiotic resources per tonne of MSW management. The valued net damage is -$72.5 per tonne of waste management in Nonthaburi, which means that $72.5 can be saved to the society by avoiding the extraction of fossil fuels and mineral resources for virgin manufacturing process. This is a very good indication of the effects of recycling on sustainability of the entire system.

5.4.2 Economic sustainability assessment of the existing MSW management system

LCC was selected as end composite indicator to assess economic sustainability, considering the overall cost and revenues from the existing MSW management system in Nonthaburi.

-Life cycle cost for recycling

For the recycling process, LCC was done for the process activities at two major places such as sorting facility and recycling facility. The detail LCC cost estimations at sorting and recycling facilities are shown in Appendix A.

In order to calculate the gross LCC for the recycling process chain, LCC at the sorting pant and LCC at the recycling facility should be added together. Selling prices of all the produced primary recycled products were also taken into account to calculate the net revenues. In addition, credited environmental cost for avoidance of virgin production processes was considered as indirect revenue for Life Cycle Revenue (LCR) calculation. Then net LCC calculation was done by subtracting Total LCR from gross LCC, as shown in Table 5.2.

It can clearly be noticed that potential revenues from recycling of all type of recyclables are higher than the gross LCC, so that net profits can be expected, as shown in Figure 5.3(a). Aluminium recycling was identified as the most economically feasible recycling process. The reason is that aluminium is a finite resource and there is a large demand for it, so that the selling price of recycled aluminium is very high. Considering LCC and LCR for the entire recycling process chain of all of the recyclables, gross and net LCC were calculated for one tonne of mix waste recycling in Nonthaburi. The analysis result has clearly proven that recycling is an economically attractive option since there is a potential of generating 11,344 baht per tonne of mix recyclables as the net earnings, as shown in Table 5.2 and Figure 5.3(a).

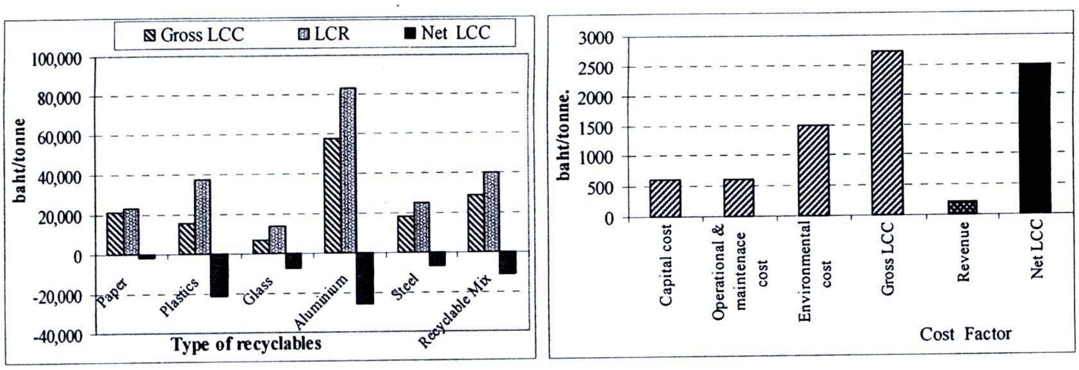
Table 5.2: Gross LCC, LCR and net LCC per tonne of waste recycling in Nonthaburi

	Cost (baht per tonne)			Life Cycle Revenue (baht per tonne)			
Type of recyclable	**Gross LCC at sorting facility**	**Gross LCC at recycling plants**	**Gross LCC for process chain**	**Revenue from selling of recycled products**	**Credited environmental cost**	**Total LCR**	***Net LCC**
Paper	4.80E+03	1.66E+04	2.14E+04	2.04E+04	3.05E+03	2.34E+04	-2.06E+03
Plastics	8.63E+03	7.21E+03	1.58E+04	2.68E+04	1.06E+04	3.73E+04	-2.15E+04
Glass	1.25E+03	5.43E+03	6.68E+03	1.01E+04	3.95E+03	1.40E+04	-7.34E+03
Aluminium	5.19E+04	5.50E+03	5.74E+04	6.00E+04	2.33E+04	8.33E+04	-2.59E+04
Steel	1.10E+04	7.32E+03	1.83E+04	1.90E+04	6.23E+03	2.52E+04	-6.90E+03
Recyclable Mix	**1.97E+04**	**8.82E+03**	**2.85E+04**	**2.98E+04**	**1.00E+04**	**3.98E+04**	**-1.13E+04**

(* 32.11 Baht = US$ 1 - August 2010)

-Life cycle costing for landfilling

LCC analysis for the existing landfill would be an attractive point in the decision-making process for further upgrading of the existing system. At present, 76% of generated waste is being disposed at Nonthaburi landfill and the local authority is spending a lot of money for operating this landfill. LCC of existing sanitary landfill was calculated by adding up all the capital costs, operational and maintenance costs and environmental costs, as shown in Figure 5.3(b). Environmental costs were calculated based on the Swedish EPS model (Steen, 2000). WTP values were derived, based on income elasticity of WTP for Thailand (CIA, 2008), see Appendix A (Table A 11). By accumulating all the components of cost, the calculated gross LCC is 2,723 baht per tonne. Moveover, in order to calculate the net LCC, potential revenues from MSW management are required. The only revenue for Nonthaburi municipality is the fee that is collected from households, for providing the MSW management service. Each household is paying 20 baht per month for the service and total number of households within the municipal limits is 120,000. Therefore, total income for municipality is 2,400,000 baht per month. Based on that, the estimated income for providing the service is 216 baht per tonne of MSW. Thus, net LCC for landfilling of MSW in Nonthaburi amounts to 2,506 baht per tonne, as shown in Figure 5.3 (b).



(a) (b)

Figure 5.3: (a) Gross and net LCC of recycling (b) Gross and net LCC of landfilling

-Life cycle costing for existing system

By aggregating the financial analysis results of both recycling and landfilling, the net LCC was estimated for the existing MSW management system in Nonthaburi. About 24% of waste goes for recycling and the revenues from recycling can cover all the costs which are spent by municipal bodies for landfilling, as shown in Table 5.3.

Table 5.3: Summary of net LCC of the existing MSW management system

LCC of different treatment methods	**Net LCC (baht)**
Net LCC of recycling of 24% per tonne of generated waste	-11,344 baht/tonne x 24/100 = -2,723 baht
Net LCC of landfilling of 76% per tonne of generated waste	2,506 baht/tonne x 76/100 = 1,905baht
Net LCC of the existing MSW management	**-818 baht per tonne**

The estimated net LCC for the existing MSW management system is -818 baht per tonne of waste generated, indicating a revenue. Although, 76% of the waste generated is disposed in landfilled, the system has reached economic feasibility as a result of the 24% of waste that is recycled in Nonthaburi.

5.4.3 Social sustainability assessment of the existing MSW management system

-Quantification of "damage to human health"

To quantify damage to human health, the methodology detailed in Chapter 4 has been followed. Characterization factors of health damage for the different types of emissions are shown in Appendix A (Table A.12). Based on the life cycle inventory analysis results of the existing MSW management system in Nonthaburi, potential health damages were quantified from both recycling and landfilling as mortality, severe morbidity and morbidity. Then all the effects were added up to estimate the total health damage in terms of DALYs. It is noticed that for all types of recyclables, potential health damages due to emissions from recycling, are much lower than that from corresponding virgin production except for plastic, as shown in Figure 5.4.

As far as health damages are concerned, the most valuable recycling process is aluminium recycling due to two major reasons. First, it uses less energy in comparison to other recycling processes which results in lesser emissions. Second, recycling of aluminum helps to cut down the large amount of health damages that could have otherwise occurred from virgin production aluminum, as shown in Figure 5.4. Considering all the fractions of recyclables, the potential health damages were estimated from the recyclable mix in Nonthaburi. It was found that health damages avoidance potential from the recycling process of one tonne of mix recyclables is -9.32E-03 DALYs.

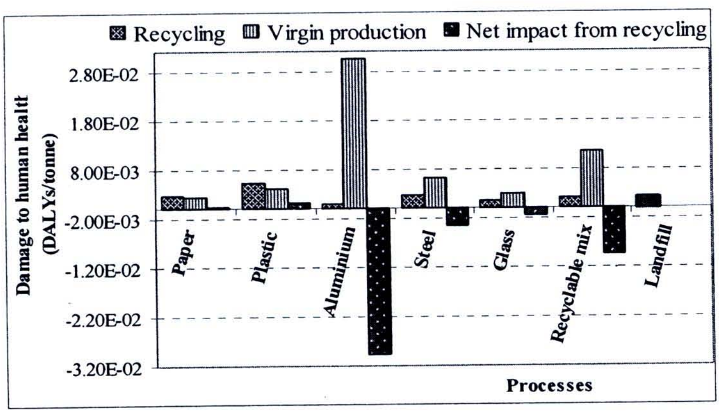


Figure 5.4: Potential health damages from recycling and landfilling

The result is a net negative damage value per tonne of mix recyclables due to the credited impacts for avoidance of health damage from virgin production. Promoting recycling considerably influences the avoidance of diseases resulting from virgin production mainly from the emissions associated with the pathways leading to global warming and human toxicity. In fact, 76% of health hazards avoidance potential from recycling results from prevented emissions leading to global warming and that would have otherwise occurred from virgin production of recyclables. The remaining 24% of health hazards avoidance potential ensue due to the preventing direct and indirect exposure to human toxicity compounds that would emit from the virgin production. Those results indicate that recycling is favourable as a sustainable option with regards to human health, as shown in Figure 5.4.

In contrast, the presently operating landfill in Nonthaburi is responsible for damages to human health, especially from the emissions of greenhouse gases (34 kg of CH_4 is being emitted per tonne of MSW landfilled) and compounds associated to human toxicity (NH_3, NO_x) during the degradation process. By adding all the potential life losses or disabilities that may arise through the various damage occurrence pathways, the estimated health damages caused from landfilling amounts to 1.97E-03 DALYs per tonne of waste landfilled. Of this, 81% of the health damages arise due to the effects of global warming and the remaining 17% due to direct and indirect effect of human toxicity compounds. Considering the fractions of waste that are being treated by using both recycling and landfilling, total estimated health damage per tonne of MSW management in Nonthaburi is -7.38E-04 DALYs. The net negative damage value obtained highlights the benefits of from recycling; since it contributes offsetting the health damages occurring from landfilling.

-Quantification of "Income based community well-being"

Poverty alleviation through economic development would be the major factor that would bring about the well-being of the community. MSW management based employment opportunities as well as income generations were accounted for throughout the life cycle to quantify the improvement of living standards as compared to the existing system in Nonthaburi.

At present, the community is earning a significant amount of money by selling point source separated recyclables. For instance, by selling daily generated recyclables (90 tonnes), the indirect income generation potential to the community is 1.57 million baht. When calculated per tonne of mix recyclables, it amounts to 17,440 baht per tonne. The major share of income has been generated by the sale of aluminium and metals. As there is a good price for these types of recyclables, people in the community pay more attention on collecting and selling such recyclables. The total income generation potential from various types of recyclables is shown in Table A.17 (in Appendix A). In addition, the recycling process chain enables generating 675 of skilled employment opportunities to the community at various positions from waste collectors to managing directors. Therefore, the wages based income generation potential to the community amounts to 2,900 baht per tonne of mix recyclables, as it requires 7.5 labour days per tonne of mix recyclable for recycling, as shown in Figure 5.5.

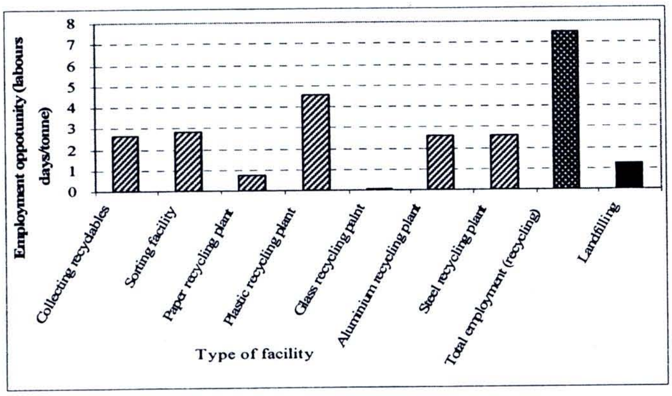


Figure 5.5: Employment opportunities at various recycling facilities and landfill

According to the evaluation results, total income generation potential from direct (selling recyclables) and indirect (wages based) sources of the recycling process is 20,300 baht/tonne of recyclables. To provide a meaningful explanation "per capita living expenses" of middle class people was taken into account (per capita living expenses of middle class people is 5,000 baht/month). Thus, the recycling based income increment will be sufficient to cover the monthly expenses of 4 individuals enabling to bring about better quality of life. However, still the major fraction of generated waste is being landfilled. In total, 332 employment opportunities are created for the 280 tonnes of MSW collection, transportation and disposal processes. Therefore potential employment opportunities per tonne of waste landfilled is 1.2 labours per tonne, as shown in Figure 5.5. Wages based income generation potential is 330 baht per per tonne of MSW landfilled.

Similarly to other indicators, in order to estimate the social benefits from the existing MSW management system in monetary terms, both direct and indirect benefits from landfilling and recycling were aggregated. The resulting social benefits in monetary terms were found to amount to 5,130 baht per tonne of waste. This would contribute to uplift the living standards of the community.

5.4.4 Sensitivity analysis and future perspectives

The study revealed that 24% of generated waste recycling in Nonthaburi has resulted in remarkable outcomes with respect to environment protection, revenue earnings and social benefits. It identified that recycling has the potential for making a great influence in improving three-dimensional sustainability. Therefore, a sensitivity analysis was performed to assess the three-dimensional sustainability improvement with an increasing recycling rate. In Nonthaburi, a considerable fraction of un-recovered recyclables (87 tonnes recyclables per day or 23 % of generated waste) is still being disposed at the landfill along with mixed waste, which has occupied a large extent of land.

As Nonthaburi municipality is making a significant effort on improving recycling via public participation and strong political will, the rate of recycling would increase in the near future. For instance, if they achieve the targeted 30% of generated waste recycling by 2012, instead of current rate of 24%, the overall MSW management system would have the potential of further improving 27% of ecosystem protection, 26% of abiotic resource protection, 102% of revenue earning, 92% of health damage avoidance and 24% of community well-being, as shown in Figure 5.6. Figure 5.6 also shows the sustainability achievement potential with further improvement of the recycling rate (35% of generated waste). Overall sustainability of the waste management system in Nonthaburi is highly sensitive to the recycling rate. These sensitivity analysis results clearly indicate the three-dimensional sustainability improvement potential of overall MSW management via an efficient and effective recycling program.

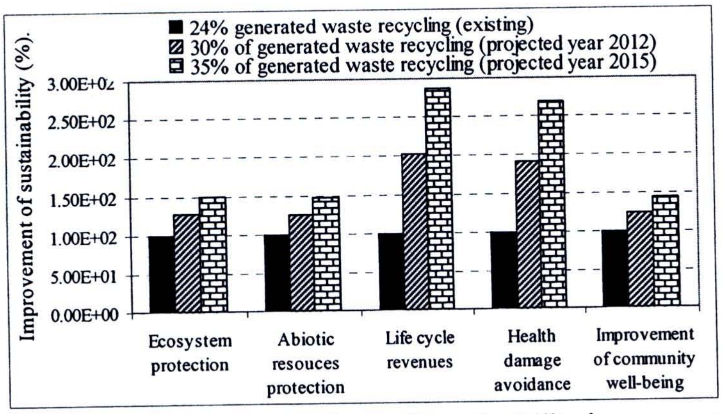


Figure 5.6: Future perspectives of sustainability improvement by increasing the waste recycling rate

5.5 Conclusion

Nonthaburi municipality was identified as a good example for working towards a sustainable solution to overcome the existing MSW management crisis in Thailand. To assess the sustainability, developed environmental, economic and social indicators were used and quantified the ultimate damage/effects of MSW management. Recycling was found to improve sustainability of MSW management for all three-dimensional aspects of sustainability. It was found that 76% of the municipal waste generated is landfilled contributing to considerable environmental degradation, economic losses and social burdens. As Nonthaburi municipality is recycling 24% of its waste, it contributes a significant impact on the overall sustainability of the existing system. However, recycling cannot stand alone as an independent technology for prolonging sustainability of a waste management system. Thus, further improvements are required to reduce the environmental degradation, economical losses and social burdens associated with the existing landfill. The results of this study will serve as a baseline for further improvement of the existing MSW management system in Nonthaburi.