Waste Reduction and Recycling Strategies for the In-flight Services in the Airline Industry

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Abstract

Air transport is one of the world's fastest-growing industries. Today's worldwide tourism and international exchange of goods and services would not be possible without aircraft. Solid waste management and disposal is one of the most significant issues in the environmental management of the airline industry. In this study, a waste composition analysis was conducted for in-flight service waste, and potential waste minimisation measures were evaluated. The total in-flight waste was estimated to be up to 500 kg per flight, including food waste, and galley and cabin waste. The waste composition analysis showed that paper (mainly newspaper, meal menu cards, *etc*.) was the largest component, ranging from 32% to 71% by weight of the total galley and cabin waste. Another major component was plastic items. Transparent polystyrene drinking cups and food covers accounted for up to 13% of the total weight. Aluminium cans accounted for up to 4% of the total waste. These recyclable materials can be sorted on board to facilitate the waste reduction and recycling programme. The proposed on board sorting and collection programmes can achieve a recycling rate of as much as 45% - 58% of the total galley and cabin

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waste from in-flight services.

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1. Introduction

Today's global economy and worldwide distribution of labour would be unthinkable without the enormous progress made in the evolution of mobility by means of trains, automobiles and aircraft. Supported by air transport, industry is able to move goods promptly from one continent to another. Equally important are the trips that make it possible for business people to establish and maintain working relations with their counterparts around the world (British Airways Limited, 1995; Lufthansa, 1997).

Air transport is one of the world's fastest-growing industries. This is particularly the case in the fast growing Asia-Pacific region. Worldwide tourism and the international exchange of goods and services would not be possible without aircraft. There is no end in sight to this fast pace of development, as experts predict annual growth rates of 5 to 6 % for some years to come. The number of leisure travellers will increase to one billion per year in 2010, according to predictions by the World Travel Organisation (Lufthansa, 1997).

As the modern world develops at an ever-increasing rate, mankind now faces some of the consequences of its development. The depletion of natural resources and disturbances in the environment are some alarming aspects of this worldwide crisis. Like any other industry sector in the modern world, the airline industry also faces many environmental problems, including

noise, gas emissions, waste, wastewater, and tourism and conservation (British Airways, 1995; Lufthansa, 1997).

Solid waste management and disposal is one of the most significant issues in the environmental management of the airline industry. The economically sound and environmentally acceptable disposal of municipal solid waste is a major concern in many industrialised countries (Tchobanoglous et al., 1993; Sakai et al., 1996; Tanskanen, 2000). Like communities and businesses worldwide, the airline industry is facing stringent legislation and public pressure on waste management (Jacalone, 1993; Pratt and Phillips, 2000). There are many different sources of waste within the airline industry. As a core operation element, the in-flight passenger services generate about 68% of all the dry waste (British Airways, 1995).

Knowledge of the sources and types of solid wastes, along with data on the composition and rates of generation, is very important to the design and operation of the functional elements associated with the management of solid waste (Tchobanoglous et al., 1993; Daskalopoulos, 1998; Fehr et al., 2000). As part of its Greening Scheme, Cathay Pacific Airways Limited (CPA) in 1996 commissioned a study to examine the waste generation patterns of its operations and to identify appropriate waste reduction and recycling methods (CPA, 1997). During the project, a waste composition analysis was conducted for in-flight service waste, and potential waste minimisation measures were evaluated. This study may be the first research project on the waste composition and quantification analysis of in-flight services in the airline industry. The paper presents the major findings of the in-flight waste composition analysis conducted during 1996-97. The results will be helpful for other airline companies and similar industrial sectors to set up their waste minimisation and waste management systems.

2. Methodology

In order to understand the nature of in-flight wastes, a waste composition analysis was carried out in the project. Eight representative CPA flights were selected for the analysis, including two long-haul (European and North American routes), two medium-haul (Australian and New Zealand routes) and four short-haul flights (Asian routes). In-flight waste consists of two types of waste streams: galley and cabin waste, food waste in the food carts. Galley waste includes trash from the waste bins and trash compactors. They are generally collected by cabin crew during the in-flight services and disposed of at the bins. Some bins are operated with a compactor to reduce the volume of the waste. Cabin waste is the trash collected during the cleaning of the passenger compartment of an aircraft after landing. Food waste and packaging materials in meal trays are kept in food carts and transported directly to the washing lines of the caterer after landing. A separate analysis was carried out in this study to evaluate the quantity and composition of food waste generated from in-flight services.

The galley and cabin waste was collected and stored in bags and liner boxers from the eight CPA flights returning to Hong Kong from their respective routes. They were labelled with the flight number, origin (class of service) and date of collection during aircraft cleaning. After the collection was completed, the waste was delivered to the Hong Kong Polytechnic University for composition analysis. The waste was sorted manually according to the flight routes and classes of service into 14 categories (see Table 1). The different categories of waste reflect various raw materials, waste origins and potential recyclability. The gross and net weights of each category of waste were measured and recorded on a form with respect to the route and service class. The results discussed below are based on the average waste composition of each

flight type sampled in the study.

Food waste from the returned food carts of eight CPA flights after landing in Hong Kong International Airport was retrieved from the receiving area of the Cathay Pacific Catering Services (CPCS). The waste was manually sorted according to the major types of food served during flight. The weights of each sorted waste category were measured to record the quantity of untouched food and different food scraps. Potential recyclable packing materials (*e.g.* aluminium foils, plastic covers *etc*.) were also quantified in this analysis.

3. Results and Discussion

3.1 Waste generation

The average quantities of galley and cabin waste generated per passenger are presented in Table 2. Measured by weight, the economy class passengers generated the least quantity of solid waste per person (0.38 kg), while the first class passengers generated the most (up to 2.84 kg per person). The large quantity of waste per passenger generated in the business and first classes could be accounted for by the greater amount of high "weight to volume ratio" waste types such as food waste, glass bottles and newspaper. In general, the waste generated per passenger on long- and medium-haul flights was higher than that of short-haul flights. This was due to there being more meals and other services on board during the medium-and long-haul flights.

Assuming full load on a Boeing 747-400 (18 first class passengers, 56 business class passengers and 313 economy class passengers), the estimated quantity of cabin and galley waste is shown in Table 3. The total in-flight waste can be in the range of 134 – 234 kg for different

flight types. This type of waste is important to the waste management of any major international airport in the world.

The average quantities of food waste in the food carts are shown in Table 4. The total food waste for a full loading flight was estimated to be 152 – 244 kg for different flights in the study. The amounts of food waste from in-flight services were in a very similar range of the galley and cabin waste. The medium and long haul flights had more food waste that the short haul flights because of the multi-meal services on board.

3.2 Waste composition

3.2.1 Composition of galley and cabin waste

The waste composition of the long haul flights is shown in Figures 1 to 3. In economy class (see Fig. 1), clean paper, mainly newspaper and to a lesser extent meal menu cards, was the largest component, accounting for 32% of the total in-flight waste weight. Soiled paper (used paper towels *etc*.) was the next abundant item in the waste stream. Another major waste component in economy class was plastic items, including transparent polystyrene (PS), rigid and films plastic materials. PS materials, mostly originating from drinking cups, accounted for 13% of the total weight of the in-flight waste. As each PS water cup weighs about 11.5 g, an economy class passenger can use an average of 4.3 PS cups during a long-haul flight. The rigid plastic materials (beverage bottles, form plastic *etc*.) and film plastic items (packaging materials) accounted for about 8% of the total waste. Other main components in the in-flight waste included food waste (9%) and glass (9%) (see Fig. 1). Aluminium cans from the beverage services constituted about 3% of the total in-flight waste. Textile items accounted for about 4%

of the waste.

The in-flight waste compositions in the business and first classes of the long-haul flights were similar to that of the economy class (see Fig. 2 – 3). Clean paper was the major component, accounting for 41–51% of the total waste. As more extensive food services were available in business and first classes, there was more food waste, accounting for 12-21% of the total waste collected. Glass from wine bottles accounted for 14–16% of the waste stream. Other materials in the waste stream of the business and first classes included soiled paper, textile and plastic items, transparent PS and other aluminium items (Fig. 2 – 3).

The waste composition of the medium-haul flights is presented in Figures 4 - 6. The waste composition patterns were quite similar to the long haul flights. Clean paper waste was again the largest component in all medium-haul waste streams. In comparison with long-haul flights, aluminium cans and glass wastes accounted for greater shares than in the long-haul waste streams.

The waste composition of the short-haul flights is shown in Figures 7 - 8. Paper waste dominated the waste streams of both economy and business classes. However, nearly half of the waste paper in the economy class waste stream was soiled paper (tissues, napkins, tray mats, *etc*.). Transparent PS, other aluminium items and glass were other major components in the wastes of the short-haul flight sampled in the study. On average, each passenger in economy class used about 2.3 PS cups for the whole trip, which was about half of the quantity used in the long- and medium-haul flights.

The composition of in-flight service waste obtained from the present study is similar to the typical composition of residential MSW in many parts of the world (USEPA, 1990; Tchobanoglous et al., 1993; EPD, 1999; Fehr et al., 2000). The major components of the residential waste stream in the United States are paper and cardboard (42%), food waste (8.4%),

plastic (6.9%), textile (1.8%), glass (9.0%) and aluminium (0.6%) (Tchobanoglous et al., 1993). Therefore, the waste reduction and recycling systems and programmes for domestic waste can be adopted in the management of in-flight waste.

3.2.1 Composition of food waste

The typical compositions of food waste generated from CPA long haul flights are presented in Table 5. The data shows that certain food and beverage items were left untouched in large quantities, including bread, desert and small packs of sugar, milk, salt and pepper. Therefore, there may be possibilities to reduce the standard uplift quantities of these items or to offer some items only upon request. There were also considerable amounts of potentially recyclable items in the food waste stream, including aluminium foils and plastic food covers.

3.3 Waste reduction and recycling opportunities

Based the above waste composition analysis results, it is evident that waste avoidance and reduction measures can be implemented to foster better waste and resources management in the airline industry. Considering the material recyclability and marketability, and in-flight services operations on commercial airlines, the waste items generated from in-flight services, that have high potentials to be reduced or recycled, are discussed below.

Clean Paper

Clean paper waste made up the bulk of the waste, ranging from 32% - 70% of the total net

weight of the galley and cabin waste. Newspapers can be offered to passengers at the boarding area or gate in order to reduce the waste generation on board the aircraft. Used menu cards (particularly those of the business and first classes) can be collected and sorted for future reuse. In order to replace paper menu cards, a programme of electronic menus on personal TV systems for passengers can be implemented in suitable aircraft types.

Newspapers and other reading materials from in-flight services can easily be recovered from the waste stream for recycling. Periodic collection by cabin crews during the flight journey and subsequently collection by cleaning staff after landing can achieve a much high paper-recycling rate and reduce substantial waste quantities to be disposed of.

Transparent PS materials

Another important waste item is the transparent polystyrene products used on board. Polystyrene drinking cups and food covers account for 2% - 10% of the total in-flight waste. To avoid the waste generation, passengers can reuse their cups during flight if a cup holder is provided at passenger seat, especially at the economy class. Some unnecessary plastic items, such as glass cup holders, can be replaced in order to reduce the waste generation.

The types of plastic materials used for in-flight serviced should be minimised in order to increase recycling opportunities. The separate collection of these PS items on board can facilitate the final recycling programme of these materials on the ground. In addition, plastic food covers in food carts can also be recovered during the washing process by the catering contractors for further recycling.

Aluminium cans

Aluminium can waste is generated from beverage services during the flight. Used aluminium cans accounting for 2% - 4% of the total in-flight waste stream have high recovery value. Aluminium cans can easily be sorted and stored during in-flight services for subsequent recycling programmes. Aluminium foils in the meal trays can be collected during food cart washing for recycling.

Food waste

A preliminary analysis of the nutrient values of the food waste generated from in-flight services shows a protein content ranged 9% – 20% (dry weight bases). The results indicated that the waste food could be suitable for reprocessing for animal feeds. If this approach is adopted, it can help to reduce significant amounts of waste from in-flight services. The plan for a proposed food waste recycling facility in Hong Kong is currently under detailed study.

Based on the assumption that 90% of the clean paper, transparent PS items and aluminium cans can be recovered for recycling, the amount of galley and cabin waste that can be reduced per passenger is shown in Table 6. Recyclable materials account for 45 - 58% of the total waste stream. The total waste reduced through the proposed waste recycling scheme is estimated to be about 100 kg on a fully loaded Boeing 747 flight.

The proposed waste reduction and recycling programme has been partly used by several different leading airlines in the world (Lufthansa, 1997). The pilot trial scheme on the CPA

Green Route (Hong Kong to Zurich) has successfully demonstrated the proposed schemes from December 1997. There are plans to extend the programmes to other CPA flights in the near future.

4. Conclusions

Waste management is an important area of the environment management system in the airline industry. The waste composition analysis results of Cathay Pacific flights indicate that there are many items in the current in-flight services waste streams that can be minimised and recycled.

In the waste composition analysis, clean paper (mainly newspapers) was the largest component, ranging from 32% to 71% of the total weight of the in-flight waste. The next major component was plastic material, particularly transparent PS items (drinking cups and food covers), that accounted for up to 13% of the total weight of the in-flight waste streams. Aluminium cans accounted for up to 4% of the total waste on some flights. Food waste in the food carts was another important waste component resulted from the in-flight services.

Based on the composition analysis and current recycling opportunities, clean paper items, transparent polystyrene items and aluminium cans have been identified as the most feasible recyclable materials. These materials can be separately collected on board for the recycling programme. The recyclable items can account for up to 45 - 58% of the total galley and cabin waste from in-flight services. The waste reduction and recycling programme has the potential to contribute greatly to local and global environmental protection, and to save substantial operation costs for the airline industry.

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Table 1
The major categories of galley and cabin waste

Category	Items included
Transparent PS	PS wine cups, 5 oz PVC cups, food covers
Other PS items	disposable tea sets, napkin rings
Other rigid plastics	PET beverage bottles, yoghurt containers, children's meal containers, cocktail sticks, plastic bottle caps, foam plastic
Film LDPE	Headset packaging
Other film plastics	Any film plastics other than identifiable film LDPE, e.g. saran wraps
Clean paper	meal menus, newspaper, magazines
Soiled paper & paper composite	any soiled paper items, liquid paperboard
Food waste	any solid food waste, coffee grounds, tea bags
Aluminium cans	aluminium cans of any size
Other aluminium items	aluminium foil, nut packaging, hot food containers
Other metal items	empty food cans, steel cans, steel cutlery
Textile & linen waste	towels, overnight bags, blankets, mittens, socks, eye shades, earmuffs etc.
Glass	glass bottles, glass jars, china crockery
Miscellaneous	wax colour pens, disposable chopsticks, wine cocks

Table 2
Galley and cabin waste generation per passenger of different flights

Flight types	Waste per passenger (kilogram)			
	Overall average	Economy class (Y)	Business class (J)	First class (F)
Long-haul	0.56	0.38	1.14	2.84
Medium-haul	0.58	0.48	0.85	1.57
Short-haul	0.40	0.21	1.20	--

Table 3
Cabin and galley waste generation of different flights

Flight types	Waste generation (kilogram)			
	Total	Economy class (Y)	Business class (J)	First class (F)
Long-haul	234	119	64	51
Medium-haul	226	150	48	28
Short-haul	134	66	68	N/A[a]

Note: a -- no first class passengers in short haul flights

Table 4
Food waste generation of different flights

Flight types	Waste generation (kilogram)			
	Total	Economy class (Y)	Business class (J)	First class (F)
Long-haul	211	148	45	18
Medium-haul	244	132	86	26
Short-haul	152	96	56	N/A[a]

Note: a -- no first class passengers in short haul flights

Table 5.
Composition of food waste of long haul flight based on full loading of passengers

(Unit: kg)

Materials	Economy Class	Business Class	First Class
Leftover Food (consumed)	48.0	5.5	2.9
Untouched Food -- Salad	8.5	1.4	--
Untouched Food -- Desert	24.5	1.8	1.4
Untouched Food -- Main Dish	15.6	2.8	3.6
Untouched Food -- Bread	28.3	3.3	2.5
Untouched Food -- Biscuit & Cheese	6.3	4.3	1.1
Untouched Food -- Beverage	12.4	4.9	6.2
Untouched Food -- Sugar, milk, salt and pepper	15.6	1.0	0.9
Paper items (napkins etc.)	3.3	0.9	0.2
Polystyrene (PS) items (food containers and covers etc.)	7.0	1.1	1.4
Film plastic	1.0	0.5	0.2
Aluminium items (beverage cans, foils etc.)	9.6	0.3	1.1
Other items (cakes, cereal and fruits)	11.3	3.6	4.6

Table 6
Waste reduction achievable per passenger (unit: kilogram)

Waste reduction potential	Long-haul	Medium-haul	Short-haul
Clean paper waste	0.20	0.21	0.20
PS waste	0.04	0.04	0.03
Aluminium cans	0.01	0.02	0.01
Total reduction	0.25	0.27	0.24
% recyclable of total waste	45%	46%	58%

Figure Captions

Fig. 1. Composition of galley and cabin waste from economy class on long-haul flights.

Fig. 2. Composition of galley and cabin waste from business class on long-haul flights.

Fig. 3. Composition of galley and cabin waste from first class on long haul flights.

Fig. 4. Composition of galley and cabin waste from economy class on medium-haul flights.

Fig. 5. Composition of galley and cabin waste from business class on medium-haul flights.

Fig. 6. Composition of galley and cabin waste from first class on medium-haul flights.

Fig. 7. Composition of galley and cabin waste from economy class on short-haul flights.

Fig. 8. Composition of galley and cabin waste from business class on short-haul flights.