The Problem of Food Waste in Aviation and its Improvement Strategy: A case study of XY Airlines' passenger response and Suppliers

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Abstract

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The global food waste crisis stands as a critical challenge impacting the future trajectory of our world. A report released by the United Nations Environment Programme on March 27, 2024, underscored the stark reality that 783 million individuals continue to suffer from hunger, while one-third of the global population grapples with food scarcity. Despite its significance, food waste within the aviation sector has long been neglected. The International Air Transport Association has highlighted that airlines generate a staggering 5.7 million tons of cabin waste, with a substantial 80.5 percent comprising leftover food and beverages.

In view of this urgent problem, this paper conducted an empirical study on the relationship between the attributes of meals provided by XY Airlines and the amount of leftovers through questionnaire survey. This paper introduces the general situation and research objectives of the whole paper from the introduction, and describes the history of airline food and the current situation of airline food waste faced by airlines through literature review, taking XY Airlines as an example. Through the questionnaire survey method, SPSS analysis and discussion results, the whole paper and learning experience are summarized.

The thesis commences by tracing the historical evolution of aviation cuisine while dissecting the current landscape and associated challenges. Subsequently, through a meticulous questionnaire survey, passengers were engaged to assess and rate the in-flight meals provided by XY Airlines. The ensuing analysis focused on unraveling the correlation between the attributes of in-flight meals and the remaining quantities of airline provisions. Finally, the discourse delves into strategies for repurposing surplus airline meals.

This study harbors dual objectives. Primarily, it aims to curtail the residual waste of airline provisions by enhancing the culinary attributes of in-flight meals. Secondly, it endeavors to proactively address and diminish food wastage at its source through the implementation of sustainable food waste management policies. Through these joint efforts, the study aims to promote sustainability and efficiency in the aviation industry, foster responsible consumption for passengers and the global environment, and promote a culture of reducing food waste.

Key words
Airline catering, In-flight meals, passengers, food waste, recycle

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1 Introduction

1.1 Research Background

Numerous airlines are implementing personalized services both on the ground and onboard to enhance service quality, with a particular focus on retaining satisfied passengers and attracting new ones. (Zahari, Salleh, Kamaruddin & Kutut 2011, 1777). In-flight dining is another important aspect of airline operations, and it is now seen as an important part of marketing strategies to attract business and leisure travelers, with several airlines, including Sichuan airlines and Emirates, launching ads focused on in-flight food.In the air operations sector, the provision of on-board catering services has become a key focus due to its enormous cost and direct impact on customer service standards (Goto, Lewis & Puterman, 2004, p. 107).

The significance of airline meals extends beyond their role in publicity and marketing; the substantial costs and wastage associated with these meals pose challenges to the sustainable development of the aviation industry. Airline food is a tiny part of the entire aviation industry, and its waste and surplus are easily ignored when considering green flying. But Michael Bauer, an air cabin and cargo architect, estimates that each passenger generates about 1.43 kilograms of cabin waste per flight, more than 20 percent of which is unaffected food and drink. According to a survey published by the International Air Transport Association in 2021, the total amount of airline cabin waste is forecast to be 6.1 million tons by 2030, which is expected to double by 2030, and the situation becomes even more dire (AIRBUS 2024).

Table 1. Overlay matrix (Peltonen 2017, 3)

Investigative questions	Theoretical framework (chapter)	Results (chapter)	Questionnaire questions
1. What is the basic personal information of the sample population?	3.4	4.1	1-2
2. What was the interviewee's experience with XY Airlines?	3.4	4.1	3-4
3. What is the respondents' overall perception of in-flight meals/food attributes?	3.2	4.2	5(Contains 13 scale questions)
4. How receptive are respondents to in-flight meals/food attributes?	3.2	4.3	6(Contains 10 scale questions)
5. How satisfied are respondents with in-flight meals/food attributes?	3.2	4.4	7(Contains 11 scale questions)

6. How do passengers deal with the waste of in-flight food?	3.1	4.5	8-11
7. What are the remaining factors that affect in-flight food?	3.1	4.5	12-13

1.2 Research Objectives

This academic investigation into food wastage within the aviation sector is centered on addressing the specific challenge of excess food disposal within XY Airlines. The primary aim is to mitigate the overall volume of food waste generated by the airline by enhancing passenger satisfaction with onboard dining experiences and optimizing the recycling of food supplies within the airline's operations. In order to appeal to today's society with dwindling global resources, in addition to developing green energy, the airline group also needs to pay attention to the phenomenon of food waste, while reducing costs and increasing efficiency for airlines. As a supplement, XY Airlines is an airline based in a city in northern China. The reason why I choose XY Airlines as a case study is through a simple communication with the crew on board. Historically, XY Airlines has not devoted substantial attention to or conducted in-depth inquiries into the issue of food wastage. Therefore, the main purpose of this study is to find out the root cause of food waste in XY Airlines and propose strategies to improve food waste in aircraft to effectively reduce food waste.

1.3 Research process

Employing a quantitative research approach, this study relies predominantly on a questionnaire survey methodology. Taking inspiration from the study published by Zahari, Mohamad, and Aqilah(2021) on the interaction between food quality/attributes and passenger satisfaction, their findings also illustrate a significant correlation between food quality and passenger satisfaction levels. At the same time, it is also mentioned in the thesis that the quality of food directly affects the reduction of waste. Therefore, we used questionnaire survey method based on five-point Likert scale to design relevant questions. A questionnaire survey was conducted on passengers who have taken XY airlines for a long time, and representative data were obtained as far as possible for analysis. The average and standard deviation of passenger ratings were used to judge passengers' recognition and satisfaction of XY Airlines in-flight food. The questionnaire survey method was carried out by sending questionnaires online. The design and collection of online questionnaires were carried out based on the questionnaire Star software. After data collection, the analysis was mainly carried out based on the SPSSAU website. At the same time, observation method

and simple personal interview survey are also used in this study. Finally, according to the numerical results of analysis and the results of the non-scale option questionnaire, the improvement strategy of XY airline meal was discussed.

1.4 Research scope and significance

The scope of literature research in this study mainly focuses on the problem of food waste in aviation and the attributes of meals on XY aircraft, with the purpose of exploring the factors affecting the remaining amount of meals in flight. Firstly, by delving into the historical evolution, current landscape, and prevailing challenges within the realm of airline catering, this study sheds light on the gravity and repercussions of food wastage within the aviation industry. Secondly, through literature review, the report of the International Air Transport Association and the relevant data of the United Nations Environment Programme are discussed, highlighting the important impact of the global food waste crisis on the future development of the world. In addition, the literature review also covers the relevant research on the generation of airline cabin waste and the neglect of food waste by airlines and related enterprises. Through the comprehensive analysis of the existing literature, the paper provides theoretical support and background information for the aviation food waste problem concerned in this study.

There is a growing interest in airline food. Especially after the terrorist riots and epidemic, people's safety awareness and climate change have made the safety quality and environmental protection of aviation food production more attention.

The exploration of cabin waste management traces back over two decades, with early analyses focusing on waste stream characteristics to identify key areas for intervention and develop recycling strategies (Li, Poon, Lee, Chung & Luk, 2003). The scale of airplane waste is staggering, with airlines globally discarding an estimated 5.7 million tonnes of leftover food annually, as highlighted in a 2019 survey by the International Air Transport Association. The Sustainable Development Goals include reducing food waste, and he emphasized that by 2030, food loss must be kept to a minimum and global food waste per person must be cut in half (IATA 2019). Therefore, it is important to explore the causes of on-board food waste and how it can be effectively reduced. This still requires the continuous research of airlines and their upstream and downstream, and the design of questionnaires on food taste, freshness, appearance and menu selection to collect feedback from passengers, so as to better solve the problem of food waste in airlines.

Overall, XY Airlines was the biggest beneficiary of the study, followed by other airlines and suppliers that did not pay attention to food waste. Through a questionnaire survey of XY Airlines passen-

gers, the feedback of passengers on the food was analyzed.The food'sflavor, freshness, appearance and choice of food were used to assess passengers. According to the result data, discussions and suggestions on menu, suppliers, waste disposal and other aspects were given to finally achieve the effect that the company's surplus and waste of airplane food will be improved, and at the same time, other airlines will pay attention to airplane food waste.

2 Literature review

2.1 The development of in-flight catering

According to a historical perspective on in-flight meals, the Handley Page Transport Company offered the first official airline meal on October 11, 1919, on the London-Paris route. Guests were given a choice of sandwiches and fruits for three shillings (£1 = 20 shillings) (100 Years of In-flight Food, 2020). While this milestone marked the inception of formal airline dining, scholars such as O'Hara and Strugnell (1997) suggest that the provision of tea or coffee by British Imperial Airways on their aircraft may have laid the foundation for the evolution of in-flight culinary services.

However, due to the very restrictive conditions of the plane, all passengers had cold food for lunch, and this catering service continued for more than 20 years. This continued into the mid-1930s, after replacing a large number of new Douglas dc-3 aircraft with flying kitchens, and in 1936 United became the first airline to add kitchens and serve hot meals to passengers. While there was space to prepare food and store hot water, there was no way to heat food, so the crew brewed hot drinks and made sandwiches and other snacks in the empty kitchenette.

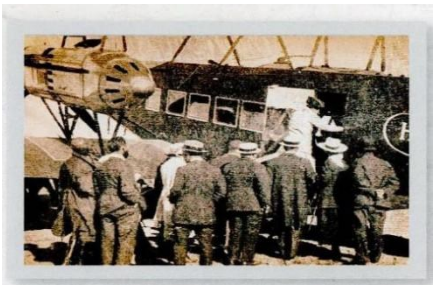

Figure 1 Passengers on Handley Page's flight from London and Paris enjoyed their first airline meal in 1919 (100 years of in-flight food. 2020)

Figure 1 Passengers on Handley Page's flight from London and Paris enjoyed their first airline meal in 1919 (100 years of in-flight food. 2020)

In the 1950s, price controls ushered in the "golden age" of airline food. According to the US authorities, airlines operating the same route must have the same price. In this context, the quality of the food on board becomes one of the key criteria that passengers use to distinguish between airlines.

However, this "golden age" lasted only a short 10 years, and then airline food quickly entered the "Bronze Age". In the 1960s, as airplanes gradually became a regular mode of transportation, more and more ordinary people began to use air services. The shift in passenger preferences towards more cost-effective dining options has prompted airlines to streamline their operations by outsourcing the production of in-flight meals to larger catering companies. This transition, while aimed at meeting consumer demands, has unfortunately resulted in a noticeable decline in both the quantity and quality of airline cuisine, particularly in economy class. Consequently, the overall standard of airline food has witnessed a gradual descent over time.. By 2009, with the popularity of sous vide cooking technology, major airlines began to use sous vide cooking machines to heat food. (100 years of in-flight food development. 2020. 15-16.)

The food selection includes anything from prepared foods and picnic kits to fine dining meals served separately. Although in-flight dining can be viewed as a promotional technique, it is more crucial because it frequently shapes a passenger's opinion of the airline in the end rather than being a major deciding element. So airlines sell food as an advertisement, and it's easy to overlook the waste behind the food, and so are customers.

2.2 Current Situation

With the rapid development of the aviation industry, airline catering, as a key customer service item, is facing a serious food waste problem. Nevertheless, the issue of airline food waste has become increasingly prominent with the rise in the volume of flights and the number of air passengers.

Presently, China, boasting the largest population globally, has emerged as the world's second-largest civil aviation nation following the United States (AEROK 25 May 2021). So the situation of food waste in Chinese airlines is self-evident, and the same is true for full-service airline XY Airlines. During an in-flight trip, we were able to have a brief conversation with a purser who had worked for more than ten years. For example, XY Airlines' in-flight meals are uniformly purchased and distributed by AVIC Food Group. Assuming the route is Jinan - Chongqing - Qingdao (Jinan and Qingdao are near), about 30 meals are wasted on each return flight. Therefore, it is estimated that China's three major airlines waste enough food to feed the population of a county town (the average population is about 400,000). A meal after the meal only four hours shelf life, more meals can only be thrown away and cannot continue to eat. In addition, if a customer needs a refill and only a new

bottle can be opened, the newly opened drink will be disposed of as garbage at the end of the trip (Flight purser 25 January 2024). Based on the communication, we found that the balance between customer satisfaction and airline food waste is really difficult. In order to achieve better customer satisfaction, the in-flight service industry will try its best to satisfy customers, virtually ignoring the seriousness of food waste.

In terms of weaknesses, XY Air must improve its food attribute quality and supply recycling service, improve the average of 30 leftover meals per flight, and formulate the destination of recycled meals to implement green recycling. It is crucial for the production of food services to adhere to a sustainable approach, focusing on enhancing economic efficiency, environmental stewardship, and social responsibility. Embracing sustainable practices is imperative for fostering growth, conserving resources, and minimizing the environmental and social footprint of aviation operations. By integrating sustainable practices into the production of food services, airlines can not only improve their operational efficiency but also contribute to the long-term well-being of the planet and society.

The aviation sector, being capital-intensive, requires substantial resources to deliver its services. The food service offered to passengers by XY Airlines exemplifies an unsustainable model of consumption and production. Due to the loss of important nutritional value and the massive depletion of land, water, and energy resources associated with food manufacturing processes, the waste of food resulting from in-flight catering operations represents a serious sustainability concern. This issue highlights the urgent need for the industry to adopt more sustainable practices to minimize waste and enhance resource efficiency, thereby contributing to a more environmentally responsible and economically viable aviation sector.

Through reading the literature, we found that XY Airlines and the current aviation industry are common problems of airline food surplus. The problem is mainly manifested in the unstable properties of food taste, packaging material waste and environmental pollution, and unclear supply and recycling management.

Oversupply of food

First of all, the current problem of airline food waste is mainly reflected in the excessive supply of food and the unstable food attributes such as quality and taste. In order to meet the tastes of different passengers and provide more choices, airlines usually provide too much food and drinks, resulting in part of the food cannot be completely consumed during the flight, and eventually wasted. According to statistics, the global aviation industry wastes millions of tons of food every year, which not only wastes resources, but also has a significant impact on the environment.

The airline industry has always been considered a very "tense and sensitive industry", not only because of the way it is transported without touching land, but also because of the nature of its transportation, which means that food can only be prepared in advance. An unique problem facing the airline catering industry is the unpredictable nature of demand, since order volumes are determined by the amount of passengers, which might change quickly before takeoff (Hasachoo & Masuchun, 2016).

Packaging waste and poor passenger awareness

The problem of airline food waste is also reflected in the waste of packaging materials and environmental pollution. In order to ensure the freshness and hygiene of food, airline meals usually use a lot of plastic packaging and disposable tableware, which often cannot be effectively recycled and disposed of after use, resulting in environmental burden and pollution.

Passengers may not have been sufficiently cognizant with the issue of food waste. Although the aviation industry has a significant problem of food waste, passengers may not always be fully aware of the magnitude of this issue. As primary recipients of in-flight services, passengers play a pivotal role in shaping the cabin service experience. (You, Bhamra & Lilley 2020). Their consumption behavior toward aviation food may affect the production of aviation food. For example, they are not satisfied with the packaging of aviation food, which may be due to plastic packaging or paper packaging, and passengers will ignore food waste due to the growth of demand and desire.

Unreasonable Supply Chain Management and Resource Utilization

The problem of airline food waste also involves the unreasonable supply chain management and resource utilization. As airlines need to provide catering services in different regions and time periods, the procurement and storage management of food materials are required to be high, but due to problems such as asymmetric information and inaccurate prediction, it often leads to waste and loss of food materials, which aggravates the problem of airline food waste.

Airlines have strategically diversified their offerings beyond mere flights, introducing ancillary products and services—especially during the online booking process—to enhance customer experience. These offerings may include options for baggage selection, advanced seat reservations, and specialized meal preferences. (Fiig, Le Guen & Gauchet 2018.)

For example, 100 years of in-flight food development (2020) mentioned that airplane food needs to go through multiple procedures from procurement, preliminary processing, hot cooking, cold cooking, refrigeration, boarding, etc. The whole "birth" process takes 10 hours, while the "life" process

only takes 6 hours. Airline food companies only have a little over 6 hours, so the time of transportation is very important. In the event of a shipping error or other shipping delay, more than 6 hours of onboard food may be discarded.

Poor Waste Management

Flying kitchens play an important role in providing in-flight meals, however, this also presents waste management challenges. According to Chang and Jones (2007), there are approximately 630 flying kitchens around the world serving more than 1 million meals per year. This means a lot of waste such as packaging, containers and food scraps need to be disposed of. However, most of the waste generated by the catering industry lacks effective control at the source, resulting in increasingly prominent environmental problems.

King (2001) pointed out that the waste generated by flying kitchens and catering industry is not fully recycled, mainly because most of the waste is not well controlled at the source. This means that a lot of resources are wasted, and it also increases the burden on the environment. To address this challenge, the aviation catering sector must enhance waste management practices, emphasizing the segregation and recycling of waste materials. Simultaneously, there is a pressing need for the industry to embrace eco-friendly packaging solutions, minimizing the use of single-use plastics and packaging materials to mitigate their environmental footprint. These efforts are crucial steps towards promoting sustainability within the aviation sector, fostering a culture of responsible resource management and environmental stewardship.

To sum up, the current situation of airline food waste has seriously affected the effective use of resources and the sustainable development of the environment.

Addressing the challenge of food waste necessitates a comprehensive approach for XY Airlines, encompassing strengthened supply chain management practices to curb oversupply and minimize food wastage, promote the sustainable use and environmental protection of packaging materials, and realize the sustainable development and resource saving of aviation catering. More importantly, explore the source of the XY airline meal surplus of about 20%. To this end, we explored from the food itself of XY Airlines' airline meals to see whether it had a direct correlation with the remaining amount of airline meals. By surveying passengers' ratings of XY Airline meals, we can help reduce the waste itself at the source, which in turn reduces the amount of work needed for subsequent recycling.

3 Research Methodology

3.1 Theoretical Support

Food waste is an increasing concern in the context of detecting and minimizing the quantity of waste produced during the process of providing food on flights. Zahari, Mohamad, and Aqilah (2021) conducted a study to examine the correlation between the quality of food and the level of satisfaction among passengers. The findings indicate that the food's quality has a direct impact on waste reduction. Consequently, to conduct a more in-depth investigation into the correlation between the quality of food and the amount of food wasted on XY Airlines, we distributed online surveys to passengers.

3.2 Research Design

This paper primarily use a descriptive research design to explore the quality of meals and the issue of food waste at XY Airlines. Descriptive research mostly employs questionnaire surveys to describe and assess the connection between the two variables.

The questionnaire design comprises five distinct sections. Section A is dedicated to gathering demographic information from respondents, such as age, gender, frequency of XY flights, and purpose of travel. The primary objective is to gain insights into the demographic profile of the individuals completing the questionnaire and explore potential correlations between variables like gender and age with the amount of leftover food on the aircraft.

Section B is structured to assess passengers' overall perceptions of the meal and food offerings onboard. Respondents are tasked with rating 13 statements to convey their sentiments towards these attributes. Moving on to Section C, this segment delves into XY Airline passengers' attitudes towards various attributes of in-flight meals. The section comprises 10 items aimed at gauging passengers' acceptance levels.

In Section D, passengers' satisfaction levels with the in-flight meals are evaluated using 11 items. Respondents are prompted to rate their satisfaction across 11 food-related aspects using a Likert scale, encompassing five points ranging from very satisfied to very dissatisfied. This structured approach allows for a comprehensive analysis of passengers' perceptions and satisfaction levels regarding the in-flight meal offerings. Within these three segments, participants are tasked with articulating their perspectives utilizing the Likert scale. The Likert scale was improved by Rensis Likert, an American social psychologist, in 1932, as explained by Baidu Baike (2024), building upon the

original summated rating scale. Individuals are directed to allocate a numerical value to each response, adhering to a five-point scale that spans from strong agreement to strong disagreement, Or from very satisfied to very dissatisfied.

3.3 Data Collection Methods

We contacted XY Airlines' customer service manager and expressed our desire to conduct interviews and surveys offline. However, because the company did not have the channel process of interview and survey in the past, and because of the large mobility of offline passengers and the tight travel time at the airport, they refused to conduct the survey, and then recommended us to conduct an online survey. One month later, I designed all the questionnaire contents according to the literature report of Zahari et al. (2011). After obtaining the approval and permission of relevant personnel, I sorted out and distributed the questionnaires through the questionnaire star software, a platform for questionnaire production.

The benefits of online questionnaires are that they are easy to implement, can collect large amounts of data quickly, and at a low cost, are suitable for collecting data from widely distributed travelers in a short period of time. The data collection process took only 7 days, and filling in online greatly increased efficiency. Considering the positive feedback and the lack of any evident problems with the instrument or technique, a total of 121 replies were gathered.

3.4 Sampling Technique

Convenient sampling method is used in the research process of this paper, which is easy to implement and can quickly obtain the advantages of samples. Although there may be some limitations in theory, such as sample bias, the research case in this paper is centered on XY Airlines, and the sample group requiring respondents are all passengers who have taken XY Airlines and eaten its in-flight food. Most of the passengers who have flown XY Airlines have eaten in-flight meals/food on their long-haul flights with the airline. According to this, the groups we surveyed were all passengers who had eaten the airline's in-flight food when they were on XY Airlines. To this end, we set a restriction condition when respondents accepted the questionnaire, that is, "This questionnaire is only open to passengers who have eaten XY Airlines' food, have you eaten XY Airlines' food and are willing to make a comment?" After the respondents select "Yes", they can fill in the questionnaire. This ensures the validity of the sample population.

3.5 Analytical Methods

This paper mainly uses descriptive statistics, and obtains mean value and standard deviation through SPSS statistical data to outline the basic characteristics of the data set, so as to provide passengers with an intuitive understanding of food attributes (flavor, freshness, appearance and choice of food) and waste situation.

3.6 Validity and Reliability of the Study

The information is encoded and entered into SPSSAU for analysis. Reliability tests were conducted separately for Sections B, C, and D by selecting suitable options. The results demonstrated strong reliability of the instruments and items used, as indicated by the Cronbach's α coefficient of 0.953 for Section B, 0.927 for Section C, and 0.934 for Section D.

The confidence of each component is higher than 0.9, probably because the overall question is mostly related to food attributes, leading to high confidence. The relevant data of validity are shown in the following table. Moreover, the data of Section B, Section C and Section D are generally between 0.7-0.8, which reflects good validity from the side.

Table 2 Validity analysis results in Section B

Items	Factor load coefficient	Common degree
	Factor 1	
The food tastes OK	0.749	0.561
The food/snack tastes the same	0.793	0.629
Most food/meals cater to all tastes	0.799	0.638
Most of the meals/food are fresh	0.806	0.650
Most of the vegetables and fruits on offer are fresh	0.804	0.647
Most vegetables have attractive colors	0.753	0.568
Most of the fruit on offer is of good colour	0.777	0.604
Overall, the food was well balanced in color combinations	0.860	0.740
The whole package looks great	0.747	0.558
Most meals/foods are adequate, or the portion size is appropriate	0.823	0.677
Most of the time, the meals/food on the tray are well laid out	0.773	0.597
The overall taste of the meal/food was very good	0.783	0.613
Overall, this airline offers more dining options than other airlines	0.766	0.587

Table 3 Validity analysis results in Section C

Items	Factor load coefficient	Common degree
	Factor 1	
The smell of the food whetted my appetite	0.792	0.628
The taste of the airline's meals was consistent throughout the trip	0.789	0.622
The mildly spicy food served by this airline is to most people's taste	0.784	0.615
I like most of the northern province specialties served by this airline	0.786	0.617
I like most of the snacks served by this airline	0.800	0.640
All the food is well seasoned with no extra seasonings	0.830	0.689
I'm impressed with the food here	0.819	0.670
I like the overall color combination of the meal/food	0.779	0.607
The taste of the food is always to my taste	0.790	0.625
I commend the cleanliness of the whole meal	0.773	0.598

Table 4 Validity analysis results in Section D

Items	Factor load coefficient	Common degree
	Factor 1	
The taste of the meal/food	0.794	0.631
The smell of the meal/food	0.778	0.606
The combination of ingredients	0.810	0.655
The freshness of the meal/food	0.749	0.561
Meal/food color matching	0.847	0.718
The packaging of meals/food	0.745	0.555
The size of the meal/food	0.791	0.626
Meal/food arrangement	0.773	0.597
Cleanliness of meals/food	0.772	0.596
The quality of the meal/food	0.807	0.652
A selection of meals/food items	0.730	0.533

4 Analysis and Results

4.1 Respondent Data

The frequency test results showed that 51.24% of female respondents (n= 62) outnumbered 48.76% of male respondents (n= 59) 98). We ensure that participants' personal information will not be disclosed. Please see the attachment for details on how to inform participants about the background of this study. A considerable number of respondents were aged between 30 and 39, accounting for 46.28%(n=56). Young people aged 18 to 29 accounted for 41.7 percent (n= 39), ranking second. Those aged 50 to 59 accounted for 9.1% (n=15), ranking in the middle, more than those aged under 18 (5.79%) and over 60 (4.1%, n=4). The purpose of vacation and leisure was the most common (47.93%, 58 people), followed by visiting relatives and friends (36.36%, 44 people), followed by business purpose (15.7%, n=19). 14.88%(n=18) had flown XY Airlines once and 42.15%(n= 51) had flown XY Airlines for the second time. 30.58%(n= 37) had taken the ride three times, 9.09%(n= 11) had taken it four times, and 3.31%(n=4) had taken it five times or more.

4.2 General Knowledge of In-flight Meals/Food Attributes

Prior to soliciting comments from participants regarding their general impressions of in-flight food, a factor analysis of exploratory nature was conducted to investigate potential connections among the variables. The items were classified according to the questionnaire's development and utilization. Through factor loading of 0.30 and Kaiser normalization utilizing variance rotation principal component analysis, three factors were discovered for all items in Sections B, C, and D. These factors include food presentation, food flavor, and food selection. (Zahari et al., 2011).

After examining the descriptive data, it was revealed that the respondents rated the flavor of the meals given as excellent (Mean=3.36, item 1), consistently enjoyable during the travel (Mean=3.32, item 2), and catering to a range of preferences (Mean=3.43, item 3). In addition, the respondents generally concurred that the meals were fresh, as indicated by the average rating for the freshness of vegetables and fruits. Significantly, the participants exhibited a comparable degree of consensus regarding the visual aspect of the dish. The alignment is clearly demonstrated in the table provided below.

Table 5 Mean score of participants' overall impression of features related to in-flight meals/food

No	Items	N	Mean	S.D
1.	The food tastes OK	121	3.36	1.106
2.	The food/snack tastes the same	121	3.32	1.171

3.	Most food/meals cater to all tastes	121	3.43	1.208
4.	Most of the meals/food are fresh	121	3.49	1.202
5.	The majority of the fruits and vegetables available are fresh.	121	3.39	1.222
6.	Most vegetables have attractive colors	121	3.43	1.148
7.	Most of the fruit on offer is of good colour	121	3.36	1.133
8.	Overall, the food was well balanced in color combinations	121	3.34	1.216
9.	The whole package looks great	121	3.41	1.111
10.	Most meals/foods are adequate, or the portion size is appropriate	121	3.38	1.17
11.	The majority of the time, the food and meals on the tray are arranged nicely	121	3.29	1.175
12.	The meal/food had an excellent overall taste	121	3.37	1.116

Scale : 1= Strongly Disagree, 2= Disagree, 3= Slightly agree, 4= Agree, 5= Strongly Agree

Apart from considering sensory attributes such as flavor, freshness, and visual presentation, respondents also expressed interest in the variety of meal options available. Respondents positively evaluated the overall flavor, freshness, and visual presentation of the food, with mean ratings ranging from 3.2 to 3.5, In addition to the assortment of food options available throughout the flight. The average score for this item (Mean=3.31, item 13) may explain how respondents feel. From the analysis in this section, it can be seen that XY Airlines, through their in-flight caterers, provide passengers with meals/food that are generally acceptable, not only in terms of flavor, freshness, appearance, but also in the selection of food.

4.3 Passenger Acceptance of In-flight Meals/Food Attributes

Regarding acceptance levels, the majority of respondents slightly agreed that they found it challenging to resist the overall delectable in-flight meals provided by XY Airlines. Overall, passengers' acceptance of XY Airlines' culinary offerings was deemed relatively moderate. Respondents acknowledged that the enticing aroma of the meals stimulated their appetite (Mean=3.35, item 1) and somewhat agreed that the taste remained consistent throughout their journey (Mean=3.2, item 2). Therefore, it is not surprising that respondents rated mildly spicy food as more popular (M=3.25, item 3), slightly preferred the taste of northern food (M=3.26, item 4), and most snacks were also more popular among respondents (M=3.3, item 5). To sum up, the meal/food attributes provided by XY Airlines have achieved a relatively average level of acceptance among domestic passengers.

This notion is upheld consistently at a higher level, as indicated by an average score for the item "all meals served are adequately spiced and do not need extra seasoning." (M=3.17, item 6).

Moreover, the responders exhibited a positive disposition towards the quality and arrangement of the meals. Their admiration was sparked by the comprehensive lunch service procedure (Mean=3.29, item 7), the harmonious color combinations (Mean=3.26, item 8), and tended to agree that the texture of the meals suited their palates (Mean=3.4, item 9). Additionally, respondents expressed confidence in the cleanliness of the meals overall (Mean=3.19, item 10), albeit noting a limited variety in the menu options, which primarily included children's meals and standard breakfast, lunch, and dinner selections. These findings underscore the significance of taste, freshness, appearance, and menu diversity to XY Airlines passengers. However, XY Airlines predominantly offers locally inspired meals, eliciting strong agreement from enthusiasts but lower ratings from those less receptive, resulting in varied responses ranging from "strongly agree" to "disagree."

Table 6 Mean score of participants' approval of features related to in-flight meals/food

No	Items	N	Mean	S.D
1.	The smell of the meal whetted my appetite	121	3.35	1.175
2.	The flavor of the airline's food remained uniform during the entire journey	121	3.2	1.073
3.	The mildly spicy food served by this airline is to most people's taste	121	3.25	1.123
4.	I like most of the northern province specialties served by this airline	121	3.26	1.134
5.	I like most of the snacks served by this airline	121	3.3	1.185
6.	All the food is well seasoned and does not require additional seasoning	121	3.17	1.155
7.	I'm impressed with the food here	121	3.29	1.157
8.	I like the overall color combination of the meal/food	121	3.26	1.186
9.	The taste of the food is always to my taste	121	3.4	1.119
10.	I commend the cleanliness of the whole meal	121	3.19	1.169

Scale : 1= Strongly Disagree, 2= Disagree, 3= Slightly agree, 4= Agree, 5= Strongly Agree

4.4 Passengers' satisfaction with In-flight Meals/Food Attributes

The results of Zahari et al. (2021) show that the quality of food directly affects waste reduction. Therefore, according to passengers' satisfaction with different quality levels of food, the waste degree of airplane food was explored. Thus, respondents' ratings of satisfaction levels associated The findings detailing these characteristics are presented in Table 7. The results indicated that respondents expressed contentment with the overall taste of the meals (Mean=3.3, item 1), the aroma (Mean=3.34, item 2), and the blend of ingredients (Mean=3.45, item 3). Moreover, the respondents expressed contentment with the quality and newness of the meals supplied (Mean=3.45, item 4). Respondents expressed satisfaction with the color schemes offered in terms of appearance (Mean=3.47, item 5), showing the highest level of satisfaction among these correlated attributes. They were generally content with the packaging style of the meals (Mean=3.35, item 6). Moreover, satisfaction with the overall portion size (Mean=3.29, item 7), meal presentation (Mean=3.24, item 8), hygiene (Mean=3.22, item 9), also texture (Mean=3.25, item 10) was relatively consistent. From this result, it is clear that respondents need airlines to adjust more appropriate meal sizes and arrange meals more neatly in order to increase satisfaction and reduce the generation of food waste.

Table 7 Mean rating of participants' contentment with features of meals served during flights

No	Items	N	Mean	S.D
1.	The taste of the meal/food	121	3.3	1.124
2.	The smell of the meal/food	121	3.34	1.121
3.	The combination of ingredients	121	3.45	1.114
4.	The freshness of the meal/food	121	3.45	1.149
5.	Meal/food color matching	121	3.47	1.176
6.	The packaging of meals/food	121	3.35	1.095
7.	The size of the meal/food	121	3.29	1.104
8.	Meal/food arrangement	121	3.24	1.074
9.	Cleanliness of meals/food	121	3.22	1.142
10.	The texture of the meal/food	121	3.25	1.184
11.	A selection of meals/food items	121	3.42	1.065

Note: 1= Not Satisfied at All, 2= Not Too Satisfied, 3= Somewhat Satisfied, 4= Very Satisfied, 5= Extremely Satisfied

4.5 Waste of in-flight meals by passengers

According to questions 8-13 of the questionnaire design, we carry out the analysis in this section. Of the total sample size of 121 people, 54.55% (n=66) said they had wasted food while flying XY. The remaining 45.45% (n=55) said there was no waste. Among the 66 people who had wasted food, 62.12% (n=41) said that the uneaten food would be recycled directly to the flight attendants. 27.27% (n=18) respondents said they would put away the unfinished food and go back to eat it. The remaining 10.61% (n=7) said they would take uneaten food off the plane and throw it away. So most of the leftover food is recycled by the flight attendants. However, based on the previous interview, we learned that XY Airlines does not have corresponding waste recycling process, but directly distributes to the local waste management station for disposal.

In order to delve deeper into the main cause of excess airline meals, we designed an open-ended question in question 10, in which half of the passengers said it was too much food served on the plane. The remaining half is basically because the type of meal does not meet the personal taste, the quality of the food is not good enough or the appearance of the packaging is not good.

According to the above statistical results, we can intuitively see the degree of passengers' attention to food quantity, food quality and packaging. According to such results, the improvement of menu, the procurement and selection of suppliers, and the recycling and treatment of waste are particularly important.

In the last two questions of the questionnaire, we also specially consider whether other factors besides the ingredients themselves will affect the dining of passengers, and then affect the remaining amount of in-flight food. Results 71.9% (n=87) of the respondents indicated that changes in mood would also affect the eating of airplane food, and there are many factors that lead to changes in mood, so we designed an open-ended question. 39.08 (n=34) respondents said that nervous or anxious mood will affect their eating mood, while the same proportion of people are not in the mood to eat airline food because of a long waiting time. Other factors that play a smaller role are flight delays or cancellations, overcrowding and noise in airports or cabins.

5 Discussion

Based on the investigation, it is evident that most customers rate the in-flight meals/food offered by XY Airlines as ranging from 3.0 to 3.5 in terms of flavor, freshness, attractiveness, scent, and components. Their scores for color combinations, portion sizes, menu choices, packaging, food arrangement and texture were in the same range. The results also showed that XY Airlines provided dishes mainly with local characteristics, which led to a low acceptability of passengers to the company's in-flight food, and some passengers could not accept the special food of northern China, such as steamed bread, dumplings, osmanthus cake, salted duck egg, mustard and other snacks. In the morning flight, compared with other airlines, breakfast is sandwiches and bread, but XY Airlines opens breakfast with millet porridge and steamed bread, which will indeed make passengers who take XY Airlines fewer times feel confused and dissatisfied. Things that are too regional characteristics are easy to lead to the polarization of passenger evaluation, so it also leads to the comprehensive average score of each item, and this type of food is really not very good-looking, easy to cause customers to be visually dissatisfied with cleanliness and packaging. The flavor consistency of the meals throughout the extended journey is commendable, although it may become somewhat repetitive. The majority of passengers expressed satisfaction with all aspects related to the food provided. The high level of passenger acceptance and satisfaction with these issues is a clear indication that XY's in-flight catering service needs to further improve the quality and mix of in-flight meals/food, improve passenger acceptance by minimizing meal sizes and foods with strong northern province characteristics, and comply with international airline regulatory standards. If we want to improve the diet to reduce food surplus, we need to implement concrete measures.

5.1 Improving the Menu

Thamagasorn and Pharino(2019) found that vegetable waste accounts for 40% to 50% of total food production during production. From the perspective of quantitative analysis, it is suggested that companies should give priority to reducing seafood waste, because reducing seafood waste has a greater impact on cost savings. XY Air is based in a coastal province, and although there is a lot of seafood, it is wise that such ingredients are generally not considered in the meal, given the freshness and allergies of passengers. Although seafood is undoubtedly a major feature of airline catering, the situation of free meals in economy class is not friendly to XY Airlines' operation, but it can be considered to add seafood to business class flights. Secondly, the more variety the menu contains, the more difficult it is to deal with the supply link, so it is better to provide a small selection.

5.2 Booking in Advance

Mortensen Ernits, Reiß, Bauer, Becker and Freitag (2022) advocate the use of in-flight personalised food service (pre-order) to reduce transaction waste. Additionally, this measure prevents a rise in food allergies, which may impact individuals' selection of meals during air travel. Hence, the utilization of in-flight catering services can both mitigate individuals' food allergies and save waste by implementing pre-orders. Pre-ordering is an effective way to reduce the amount of untreated food and drink, but XY Airlines' ticketing platform needs to improve when it comes to pre-ordering, including many third-party ticketing platforms. Whether or not meals are required is often automatically defaulted to, so passengers will take it for granted when they end up wasting. As a result, the option of whether to include a meal can be set as a mandatory option for passengers before payment, rather than an automatic default. Of course, most passengers cannot predict whether they really do not need to eat in the future, so when the mandatory options pop up, on the one hand, it is necessary to note that we encourage everyone to bring their own meals, the flight will provide free drinks, and increase incentives such as bonus points for passengers who do not need meals. On the other hand, it is also necessary to note well, if the situation changes after choosing no meal, you need to call the relevant personnel 9h before the flight departure.

In this context, Mortensen Ernitset et al. (2022) showed in a preliminary survey that although advance booking is beneficial to both passengers and airlines, awareness and use of advance booking by passengers is not widely recognized. But that doesn't deny the environmental benefits of pre-ordering, just that passenger alertness needs to be enhanced. Therefore, we can enhance customers' awareness of waste by broadcasting airline food waste data and increasing advertising slogans.

5.3 Changing Suppliers

Companies may minimize vegetable waste by opting for reputable suppliers, offering supplementary training, modifying washing procedures, and investing in advanced technologies to enhance the efficiency of selection and quality control operations, thus boosting staff productivity. (Thamagasorn & Pharino 2019). Frapin-Beauge, Bennett and Wood (1994) also argue that catering flights are an important part of airline operations. In the questionnaire survey, the surveyors gave very general comments on the taste, freshness, appearance and menu selection of XY Airlines' meals, so the above factors should be considered more when purchasing food. Active participation from all stakeholders and the government plays an important role in enhancing waste management.

5.4 Waste Disposal

The increase in tourism has resulted in a waste problem specifically in the aviation industry. The significant growth of tourism, the increase of international flights, and the dimensions of aircraft all contributed to an accumulation of solid trash. Airports generate garbage quantities that are equivalent to those of urban areas. Therefore, waste management becomes a crucial issue for major airports and represents the main difficulty and constraint facing the airline service industry. (Pitt & Smith, 2003).

Sambo and Hlengwa (2018) introduce a novel food segregation and management framework for airlines in South Africa. This model addresses food waste by allowing passengers to specify dietary preferences during booking, designates certain foods as recyclable, and facilitates redistribution to areas in need prior to resorting to landfills or composting. Airline catering firms and the airlines they serve are urged to curtail waste by pre-selecting meals during booking, segregating unused food, and contributing excess food to households requiring assistance. In certain cities along the XY route, XY Aviation could potentially collaborate with suburban farms or local plastic recycling facilities.

This model will not only help reduce food waste, but also provide practical help to society. In addition, airlines can improve their social responsibility and environmental awareness in this way. By reducing food waste, airlines can contribute to the environmental cause and move society in a more sustainable direction. Overall, this model not only helps to reduce food waste, but also has a positive impact on society. It is hoped that more airlines will adopt similar practices and jointly contribute to environmental protection and social welfare.

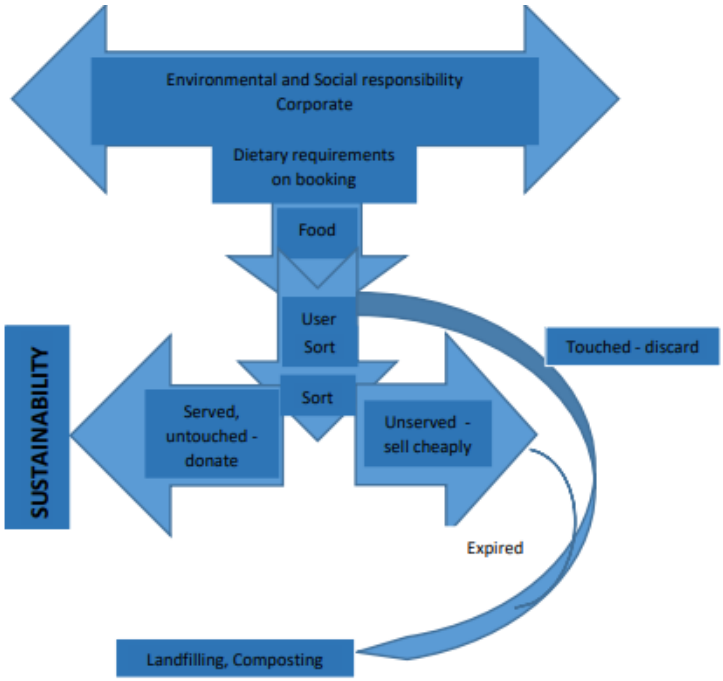

Figure 3: Waste prevention, separation and reuse model (Sambo & Hlengwa 2018)

6 Conclusion

Objective of work

The main objective of this study is to take XY Airlines as an example to analyze the current situation and reasons of its food waste management, explore the source of food waste, investigate the relevant problems of passengers' evaluation of food attributes, and propose effective improvement strategies. In addition, the study aims to highlight the potential role and responsibility of aviation in reducing food waste globally.

A recent publication by the United Nations Environment Programme (UNEP) reveals a troubling disparity: while a significant portion of the global population grapples with food insecurity, an estimated one billion meals are squandered daily, with one in every five food items being discarded. This rampant food wastage not only inflicts severe damage on the world economy but also fuels climate change, jeopardizes natural ecosystems, and exacerbates pollution levels (UN News 2024b). The aviation sector is increasingly recognizing the perils of food wastage and its implications for individuals facing famine.

Results and implementation

Through a comprehensive analysis of the food attributes of XY Airlines meals, the study successfully revealed the major challenges airlines face in managing food waste, including large portion sizes, limited choice, food quality and regional use of ingredients. The study also suggested a number of improvements, such as the implementation of customised meal services, pre-ordering meals, waste recycling management and passenger education. These results show that through a systematic approach and specific strategies, XY Airlines can significantly reduce food waste, and specific waste reductions need to be followed up over time.

Conclusion

According to the study findings, it could be inferred that all airlines, including XY Airlines, has significant potential and accountability in minimizing the waste of food. By optimizing the management of food waste recycling and improving food quality in terms of taste, freshness, and appearance, as well as enhancing menu variety, the company may not only utilize resources more efficiently but also improve its sustainability and customer happiness.

Practical application

The solution to aviation food waste depends not only on final recycling, but more importantly, the production of food services follows a sustainable approach aimed at economic efficiency as well as

environmental and social responsibility to ensure sustainable growth (Nakornkao Mongkalig, 2022). Data analytics (Yusriza, 2023) can be used to determine the final demand for catering and satisfy customer reservations (Mortensen Ernitset, 2022). To reduce waste, it is most inappropriate to switch to a better supplier (Thamagasorn and Pharino 2019). Practical applications of the findings include implementing specific food waste reduction measures within airlines, such as improving meal reservation systems to match the actual needs of passengers and using data analytics to efficiently dispose of food waste. In addition, airlines should actively participate in global food waste reduction initiatives to share best practices through cross-industry collaboration.

Success and challenge

Successful aspects include the systematic identification and analysis of the problem of airline food waste and the proposed series of practical improvement measures. The biggest success lies in finding out the root cause of XY Airlines' surplus food through questionnaire survey. However, potential issues include cost considerations in implementing new strategies, the continuity of staff training and changing passenger habits. To improve the subjective initiative of customers and employees, so that customers and employees are aware of the seriousness of food waste, is the long-term solution. Solving these problems requires the continuous support of the company's top management and the rational allocation of resources.

Improvement measure

Future improvement measures should include regular evaluation of implementation effects and timely adjustment of strategies to meet new challenges and market changes. At the same time, airlines should make greater use of technological innovations, such as AI and big data technology, to accurately predict food demand and reduce waste. In the same way, it can also be applied to waste recycling and treatment.

Future outlook

For future development, the study suggests that XY Airlines may consider developing more environmentally friendly food packaging and further integrating supply chain resources. At the same time, the aviation industry should be more broadly aligned with the global sustainable development Goals and continuously improve its performance in environmental protection and social responsibility.

Personal learning experience

In this research process, I personally deeply understand that in the face of global problems, multi-industry joint efforts and innovative thinking are needed. In the course of my thesis research, I learned how to combine theory with practice and solve complex problems by seeking collaboration. To solve the problem, we should consider starting from the source, and then clarify the framework logic, and carry out planning based on theoretical basis and factual basis. Most importantly, I planned a complete questionnaire by myself, used the Richter scale, and statistically analyzed the data with SPSS according to the collection situation. Through this research, we have not only provided practical solutions for XY Airlines, but also provided new thinking and direction on the role of aviation in the global food waste problem."

In conclusion, it is anticipated that the recommendations and insights presented in this thesis will serve to enhance airlines' comprehension of passenger requirements. By attentively addressing these concerns, airlines can strategically position themselves and enhance their competitiveness within the dynamic aviation landscape. A deeper insight into the expectations of airline passengers can foster greater sensitivity and efficacy in operational strategies, leading to heightened passenger satisfaction and a reduction in airline meal wastage. Ultimately, this holistic approach can contribute to the overall improvement of airline services and operations, fostering a more sustainable and customer-centric aviation industry.

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