Impact of Passenger Load Factor Variability on Average Daily Flight Kitchen Waste in the Flight Catering Industry of Sri Lanka

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1. Introduction

Globally, the airline catering industry produces 630 million meals a year. Variations occur between classes, distance of flights, time of day as well as special or dietary requirements. Food waste management and disposal is one of the most significant issues in the Flight Catering Industry [1]. This study, evaluates the impact of passenger load factor variability on average daily flight kitchen waste in the flight catering industry of Sri Lanka and identifies strategies to potentially minimise the food waste in flight kitchens.

The research was conducted in order to analyse, the impact of the Passenger Load Factor (PLF) fluctuation within the 24 hours leading up to the Estimated Time of Departure (ETD) of a flight on the average daily waste in flight kitchens based on historical data of international airlines, catered by the flight catering company in Sri Lanka.

2. Research Objectives

- Calculate the initial passenger load factor variability for each sector class-wise
- Assess the relationship between initial load factor variability and kitchen wise waste per meal
- Identify the importance of having forecast pax loads 24 hours before the Estimated Time of Departure (ETD)
- Identify critical sub kitchens generating more waste
- Identify the optimum PLFs for individual classes (FC, BC, EY) in each sector which minimises food waste
- Identify the importance of having meal bank to minimise waste

3. Methodology

Initial Passenger Load Factor, Final Passenger Load Factor, Passenger Load Factor Variability and Number of Meals Catered per Day are Independent Variables, and the Dependent Variable is Production Waste per Meal (kg) [2]. A combination of descriptive research, correlation research and applied research were used. The population of this study was all the airlines catered to from July to October 2017. Stratified and judgmental sampling techniques was used for sampling procedure.

The selected sample for the study was 75% percent of total meals and 80% of sectors during the research period. Flight load data were collected using secondary data collection method and the production waste data was collected using primary data collection. The data analysis was done using the MINITAB statistical software. The descriptive data analysis, Simple Linear Regression, Pearson Correlation Coefficient were mainly used in data analysis.

In the empirical analysis multiple linear regression analysis was employed. Using the regression analysis, function y = f(x) was analysed.

Daily Flight Kitchen Waste per Meal = α * *Load factor Variance* + ε

α : *Coefficient,* ε: *Error*

Pearson - Correlation Coefficient

- No of Meals per Day Vs. Kitchen Waste Per Meal
- Load Factor Variability Vs. Individual Kitchen Waste Per Meal

Research Hypothesis

- H_0 : Load Factor Variability(%) and Production Waste Per Meal(kg) are independent
- H_A : Load Factor Variability(%) and Production Waste Per Meal(kg) are associated
- H_0 : There is not a Linear Relationship between Load Factor Variability(%) and Production Waste Per Meal (kg)
- H_A : $\rho \neq 0$ There is a Linear Relationship between Load Factor Variability(%) and Production Waste Per Meal (kg)

4. Results and Discussion

Irrespective of the month, the pattern of the average daily meal count for weekdays has continued throughout the period of the research (Figure 1).

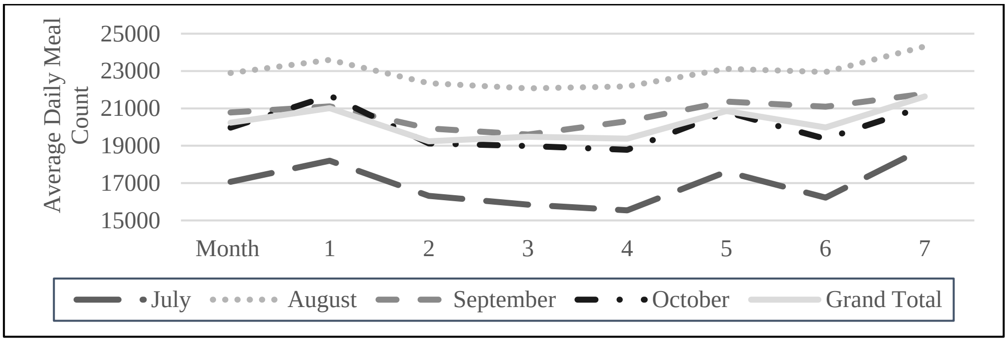

Figure 1: Daily Average Meal Count of the Population- Week Day Wise

The highest fluctuations have occurred in short sector flights (Table 1).

Table 1: Sector Wise Average Load Factor Analysis

Sector	BC-Initial	BC-Final	BC-Variance	EY-Initial	EY-Final	EY-Variance
Short (1)	37%	41%	**3%**	68%	69%	**1%**
Short (2)	56%	63%	**7%**	81%	82%	**1%**
Short (3)	53%	58%	**5%**	69%	70%	**1%**
Medium (4)	52%	54%	2%	72%	69%	-2%
Long (5)	84%	86%	2%	96%	95%	-1%
Medium (7)	39%	41%	1%	45%	45%	0%
Medium (8)	51%	53%	1%	71%	69%	-1%

The Business Class load factor variance is minimum in the months which represent the highest load factor during the period of research. The average pax loads for all classes of both airlines has increased (positive variance), indicating that the risk of load increases within the last 24 hours has been transferred to the caterer by the airline. The airline has not given a significant provision for potential load increases when they place the initial order to the caterer.

The highest waste per meal and standard deviation were detected in pre-production (Figure 2). The least waste per meal and standard deviation were detected in the confectionery. The highest portion of average waste per meal has generated by the vegetable room followed by the hot kitchen.

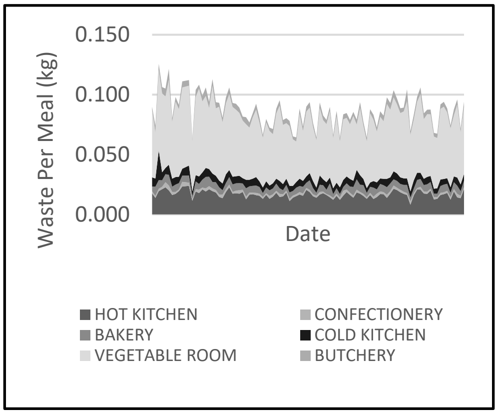

Figure 2: Daily Area Wise Waste per Meal

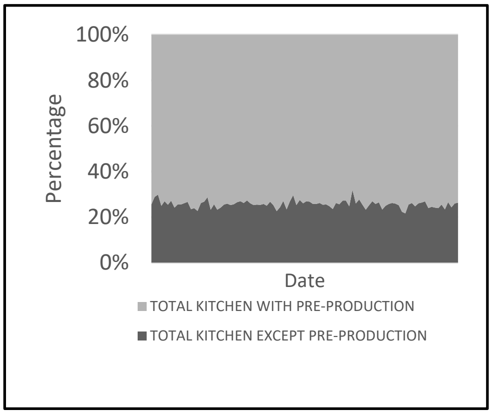

Figure 3: Total Waste Analysis - Per Production vs. Production

Total average waste per meal has followed the popular Pareto theory which is 80% of the Average Waste per meal was generated during pre-production (vegetable room and butchery) and the balance 20% was generated from the other kitchens (hot kitchen, cold kitchen, confectionery and the bakery) (Figure 3). Each sub kitchen has reported its lowest average waste per meal during the peak period, with the highest meal count of the research period. The highest waste was reported in the off-Peak months. Provision for potential increases due to the non-availability of an accurate forecast for final passenger load results in uncertainty in the production line and therefore in higher average waste per meal.

Per meal waste variation was high in pre-production (vegetable room and butchery), because multiple factors such as seasonality, quality of the raw material affect pre-production waste.

The production waste per meal reduces with the increase in number of meals per day (Figure 4 & Figure 5). Demand uncertainty has significantly affected the increase of waste in the production area. Production uncertainty where the caterer has to take into account the risk of last minutes top-ups in advance and produce more than the initial order placed by the airline creates the supply chain bullwhip effect.

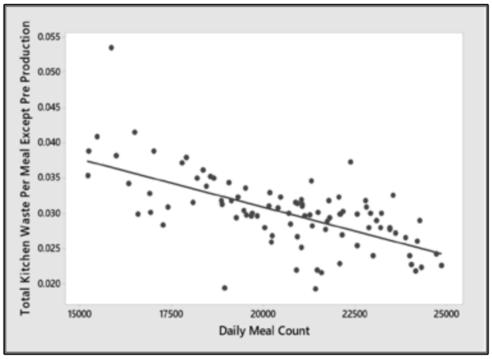

Figure 4: Scatterplot of Total Kitchen except Pre-Production Waste per Meal Vs Daily Meal Count

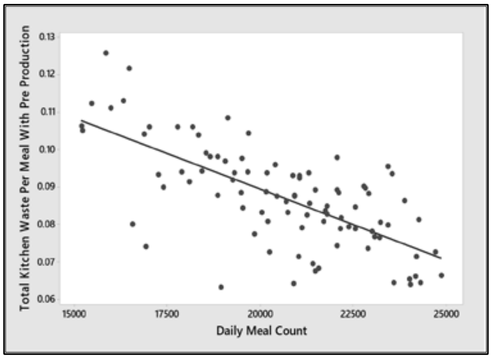

Figure 5: Scatterplot of Total Kitchen with Pre-Production Waste per Meal Vs Daily Meal Count

Minimum waste per meal was achieved when the initial PLF was 100% excepting confectionary for FC initial load factor. The First Class meal has led to an increase of waste, because kitchens produce customised products for first class meals with less standardization and the lack of mass production of such meals.

- *Average Waste per Meal in Hot Kitchen = 0.016794 - 0.000551 FC Initial Load Factor*
- *Average Waste per Meal in Confectionery = 0.001986+0.000033 FC Initial Load Factor*
- *Average Waste per Meal in Bakery = 0.005608 - 0.000420 FC Initial Load Factor*
- *Average Waste per Meal in Cold Kitchen = 0.005958 - 0.000284 FC Initial Load Factor*
- *Average Waste per Meal in Vegetable Room 0.053422 - 0.00216 FC Initial Load Factor*
- *Average Waste per Meal in Butchery = 0.004250 - 0.000351 FC Initial Load Factor*
- *Average Waste per Meal in Total Kitchen Except Pre-Production = 0.030345 - 0.001222 FC Initial Load Factor*
- *Average Waste per Meal in Total Kitchen with Pre Production = 0.088017 - 0.00373 FC Initial Load Factor*

The hypothesis test reveals (Table 2) that the mean waste per meal values are equal for different sectors, but not for different months, and that mean waste per meal values for weekdays are not equal.

Table 2: One-Way ANOVA of the Variables
(Decision Rule: P-Value ≤ α (0.05): - Reject the Null Hypothesis)

Airline	Statistic	P-Value							
		Hot Kitchen	Confectionery	Bakery	Cold Kitchen	Vegetable Room	Butchery	Total Kitchen Except Pre-Production	Total Kitchen With Pre-Production
AB Airlines	Sector_1	0.56	0.71	0.85	0.82	0.75	0.98	0.47	0.63
	Month	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Day No	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
XY Airlines	Sector_1	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Month	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Day No	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

The Pearson correlation analysis represents that preparation in the vegetable room and butchery has minimised the risk of increasing loads during the last 24 hours by producing for configuration (full passenger loads).

Average Waste per Meal in Vegetable Room Total = 0.098818 - 0.000002 Daily Meal Count

Average Waste per Meal in Butchery Total = 0.009056 - 0.000000 Daily Meal Count

5. Conclusion and Recommendations

There is a significant difference in passenger load factor fluctuations in different airlines which results in a variation in the generation of waste across airlines.

Quantity-wise the Economy Class load factor variability creates more waste in all sub kitchens. The impact of the variability of PLFs on the average waste per meal was minimal in the confectionery and bakery compared to the hot and cold kitchens due to the sensitivity of outputs, standardisation, fewer options for controlling the quality (e.g. freezing), the number of components of meals and number of processes in the meal preparation.

At present, the risk of waste generated by not increasing passenger loads will have to be borne by the caterer [3]. The demand uncertainty has led producers to prepare meals in excess of the initial passenger loads to cater to passenger load increases during last 24 hours prior to the estimated time of departure [4]. All independent variables considered are statistically significant to total waste generated in production, and this indicates the importance for caterer to develop a method of managing uncertainty regarding passenger loads of customer airlines [5].

The study recommends that the caterer considers freezing its meals to control waste as results in a better cost benefit analysis (cost of freezing vs. waste) in the hot kitchen, reducing the cycle time of the process (e.g. current bottlenecks such as blast chillers which consume approximately four to six hours of the total cycle), developing a proper forecasting system and implementing a meal bank system (standard meal storage to cater to late additions) to minimise production waste through strategic menu planning, or adopting a customized pricing strategy based on operational efficiency resulting from the provision of accurate load information.

Potential for Future Studies

- Feasibility of Different Passenger Loads Forecast Systems and the Financial and Operational Impact of implementing the Systems
- Financial and Operational Feasibility of Static and Mobile Meal Bank
- Impact of Menu Planning and Standardisation on Controlling the Waste
- Preparation techniques available in the World to Minimise Cycle time and Waste
- Impact of Frozen Meals on Reducing Waste-Operational and Financial Benefits
- Possibility of Using Ready Made (Pre-produced) Meals/Food Items for Economy Class Meals

References

[1] Morency, V. (1999). A proposal for improving the meal provisioning process at Canadian Airlines.

[2] Johan N. & Jones P. (2007). Forecasting the demand for airline meals.

[3] Li XD., Poon CS., Lee SC., Chung SS., Luk F. (2003) Waste reduction and recycling strategies for the in-flight services in the airline industry. Resources, Conservation and Recycling; 37(2):87-99.

[4] Jones, P. (2004) Flight Catering, Butterworth Heinemann: Oxford.

[5] Daniel. F. (2014), Demand Forecasting for Perishable Commodities: A Case Study of Inflight Food Demand for Low Cost Airline.

Keywords: *Food Waste, Flight Catering Industry, Passenger Load Factor, Variability, Initial Pax Load, Final Pax Load, Estimated Time of Departure*