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Optimization of Supply Chain in Food Industry with Linear Programming Approach

Kok Zheng Yu[1], Cik Sri Mazzura Muhammad Basri[1*]

[1] *Department of Mathematics and Statistics, Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia (Pagoh Campus), Hab Pendidikan Tinggi Pagoh, KM 1, Jalan Panchor, 84600 Pagoh, Muar, Johor, MALAYSIA*

*Corresponding Author: mazzura@uthm.edu.my
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Abstract

Nowadays, the industry focuses on maximizing profits and minimizing costs. Thus, the research focused on applying linear programming as an operational research technique to manage the food industry, especially on supply chain optimization to reduce costs and enhance the effectiveness of management. Linear programming was implemented to optimize the supply chain and determine the optimal solution for supply chain problems in food industry management. By testing the U.S. food import value data, the total profits earned from fourteen categories of foods from the year 2017 to the year 2022 were calculated and analyzed. Fourteen food categories were grouped into four for comparison. Overall, vegetable oils, coffee, live meat animals, and nuts contributed the highest profits for the U.S. in 2017, 2018, 2020, and 2022, respectively. Next, we investigated the relationship between the total food value and the total food volume of the fourteen food categories by analyzing the data. The result shows that the food volume of live meat animals, vegetables, fruits, grains, vegetable oils, and sugar was higher than its food value from the year 2017 to the year 2022. Live meat animals contribute the lowest food value even though the food volume is quite large, which means that it is the cheapest. In conclusion, the linear programming method is an effective and useful tool or method for an industry to manage its applications or processes of the supply chain, especially in the food industry.

1. Introduction

The food industry is a sector related to food production, processing, supply, and distribution. To help an industry and company have better management, they need to operate efficiently to stay competitive and gain more market share. Therefore, operations research (OR) techniques have become very important tools for industries and organizations to achieve their goals. OR is the study of mathematical models for some complex organizational systems. This method solves problems and makes decisions that can be applied to numerous organizations from a management point of view [1]. Savor reported that the food market is expected to grow by 6.72% annually from 2022 to 2027 [2]. Supply chain transparency is important to identifying contamination sources early and determining the root cause of product problems, but the cost to public health and the economy can be profound when supply chain transparency is lacking [3]. According to Griffith, Bittner, and Ng, continuity demands and meeting quality are crucial to supply chain responsiveness, which requires effective management of cross-functional and logistical factors [4].

This study involves the optimization of the supply chain and systems that support decision-making. Until today, there are many effective optimizations in the supply chain and systems that support decision-making, which can help an organization come out with better management in the food industry. Nowadays, many organizations and companies have started to implement supply chain optimizations and decision support systems in their management systems.

Since employees nowadays lack operational research (OR) techniques and knowledge, they cannot implement the optimization of the supply chain effectively. Therefore, in this research, we would like to show that supply chain optimization can be a better method of managing an industry effectively compared with the other OR techniques. In this research, we will focus on supply chain optimization and decision support systems in the management of the food industry.

Lopienski stated that the efficiency of the supply chain is defined as minimizing logistics costs and maximizing profits through the use of resources, technology, and expertise [5]. It refers to meeting those demands as quickly and cost-effectively as possible. The objective of supply chain efficiency is to reduce the usage of money and increase gains earned by enhancing the stages and processes in the supply chain [5]. For this research, we focus on using linear programming.

OR techniques are really important in modern life. This is because most companies and industries use OR techniques in their management system. There are several characteristics of OR. One of the characteristics is optimization which is one of the elements that involves comparing and narrowing the potential options. This can help to increase the capability and performance of the food industry from the stated requirements [6].

The management objective function in the goal programming framework minimizes the weighted average between each objective and a predetermined target level for the objectives. Two aims are required to be achieved in this study. The first aim of this study is to optimize the supply chain in managing the food industry by different categories of foods using a linear programming model. Apart from that, the second aim of this study is to determine the optimal solution to supply chain problems in food industry management by developing a linear programming model using a suitable software which is Microsoft Excel.

2. Methods

2.1 Linear Programming

To solve the problem of managing the food industry, we choose linear programming, as the OR technique. Linear programming (LP) is an effective tool and technique that can be used to solve single objectives problems. Chang and Lee stated that linear programming can be effectively used to design the best overall optimal performance in a single-objective decision problem [7]. Generally, the LP model is described below [8].

$$\text{Maximize} \quad Z = \sum_{i=1}^{m} (w_i x_i) \tag{1}$$

Subject to

$$\sum_{i=1}^{m} a_i x_i = b_i \qquad i = 1,2,\ldots,m$$

$$x_i \geq 0 \tag{2}$$

where Z is the objective function for the total food value for the types of foods imported from different countries, w_i is the total food value which is also known as the price for each type of foods, b_i is the targeted food volume for each type of foods in U.S. imported from different countries, x_i is the types of foods in U.S., a_i is the total food volume which is also known as the total weight for each type of foods in U.S. imported from different countries.

2.2 Data

The data used in this study is United States (U.S.) food imported from different countries for several categories of food from the year 2017 to the year 2022. The data is obtained from [9].

There are a total of fourteen groups of food imported from different countries in the U.S. food imports. Most of the foods in the U.S. were imported from approximately 20-25 different countries. The food value which is also defined as price and food volume which is also known as the weight of foods vary for different countries known as importers. For the data in the U.S., the food value is measured in million dollars ($), and the food volume is measured in thousand metric tons (mt). The sample of fourteen categories of foods in the data U.S. food imports were listed in Table 1.

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Table 1 *Sample of fourteen types of different categories of foods*

Categories of Food	
Live meat animals	Coffee, tea, and spices
Meats	Grains
Fish and shellfish	Vegetable oils
Dairy	Sugar and candy
Vegetables	Cocoa and chocolate
Fruits	Other edible products
Nuts	Beverages

In this research, the fourteen groups of foods were modelled into several categories to make the comparison. There are four categories of foods, which are groups A, B, C, and D, constructed to know the difference between each other in a category. First of all, live meat animals, fish and shellfish, and meats were modelled as a category named group A to make the comparison to identify which category of foods would earn the highest profits, and the total profits for these three categories of foods were calculated by the linear programming method. Next, vegetables, fruits, nuts, and grains were modelled in one group named Group B, followed by sugar and candy, vegetable oils, cocoa and chocolate, and other edible products modelled as Group C. Last but not least, the rest of the three food groups, which are dairy, coffee, tea and spices, and beverages, were modelled into another group of food named group D. The samples of four groups of foods were shown in Table 2.

Table 2 *Sample of four groups of foods*

Group	Category of Food
A	Live meat animals
	Meats
	Fish and shellfish
B	Vegetables
	Fruits
	Nuts
	Grains
C	Vegetable oils
	Sugar and candy
	Cocoa and chocolate
	Other edible products
D	Dairy
	Coffee, tea, and spices
	Beverages

2.3 Linear Programming Model

To make the comparison for the food group A, the linear programming models were created where X_1 represents the profits earned from the live meat animal, X_2 represents the profits earned from the fish and shellfish, and X_3 represents the profits earned from the meats category. Z was used to define the total profits earned from these three food categories. Thus, the linear programming model for the year 2017 is described below.

$$\text{Maximize } Z = 2016.3\,X_1 + 21924.9X_2 + 8875.2\,X_3 \tag{3}$$

Subject to

$$\text{Food Volume} : 7363.3\,X_1 + 2669.9X_2 + 1847.8\,X_3 \geq 12000$$

$$\text{Canada} : 2489.5\,X_1 + 6660.7X_2 + 4929.8\,X_3 \geq 50000$$

$$\text{Mexico} : 1430.2\,X_1 + 496.2X_2 + 2250.3\,X_3 \geq 6500$$

$$\text{Argentina} : 209.8X_2 \leq 280$$

$$\text{India} : 4533.4X_2 \geq 15000$$

$$\text{Norway} : 702.9X_2 \geq 3500$$

China : $8\,X_1 + 4841X_2 + 15.9\,X_3 \geq 7800$

Chile: $663.5X_2 + 115.1X_3 \geq 10000$

United Kingdom : $7.6\,X_1 \geq 70$

Vietnam : $2579.1\,X_2 \geq 20000$

Indonesia : $3895.4\,X_2 \geq 9000$

Faroe Islands : $85.3X_2 \geq 550$

Brazil : $58X_2 + 347.1X_3 \geq 360$

Ecuador : $3558.3X_2 \geq 6800$

Thailand : $946.7\,X_2 \leq 830$

Netherlands : $6\,X_1 \leq 25$

Russia : $384\,X_2 \leq 1000$

Germany : $1.4\,X_1 \leq 50$

Japan : $145\,X_2 \leq 450$

Spain : $27.4\,X_3 \leq 710$

Taiwan : $5.4\,X_1 \geq 15$

where $X_1, X_2, X_3 \geq 0$ (4)

Equation (3) shows the total food import value, which is also known as the total food import price for the live meat animals, fish and shellfish, and meats in the year 2017, which was 2016.34 million $, 21,924.9 million $, and 8,875.2 million $, respectively. The first constraint in Equation (4) shows the total food volume for the group A food category where 7363.3 thousand mt of live meat animals, 2669.9 thousand mt of fish and shellfish, and 1847.8 thousand mt of meats. The others in Equation (4) represent the total food value which is also known as the price for the group A food category imported from different countries in the U.S..

Next, to compare the total profit earned from the year 2017 to the year 2022 for the group B food category, the linear programming models were formed, where X_1 represents vegetables, X_2 represents fruits, X_3 represents nuts, and X_4 represents grains. Meanwhile, Z in the objective function was used to define the total profits earned from the group B food category. Thus, below is a linear programming model in the year 2017 for the group B food category.

Maximize $Z = 12670.5X_1 + 18384.6X_2 + 9066.7X_3 + 11257.6X_4$ (5)

Subject to

Food Volume : $11070.2\,X_1 + 13606.2X_2 + 550.8\,X_3 + 11854.3X_4 \geq 12000$

Mexico : $12618.5\,X_1 + 14900.7X_2 + 1284.6\,X_3 + 2763.9\,X_4 \geq 70$

Canada : $5602.6\,X_1 + 1325X_2 + 306.7\,X_3 + 10799.6\,X_3 \leq 55$

China : $1445.6X_1 + 1824\,X_2 + 169.2\,X_3 + 543.7\,X_4 \geq 550$

Brazil : $858.9X_2 + 116.9\,X_3 + 33.4\,X_4 \geq 7800$

Argentina : $112.6X_2 + 40.9X_3 + 55X_4 \leq 280$

Guatemala : $375.4\,X_1 + 3326.5\,X_2 \geq 4600$

Costa Rica:$5.7\,X_1 + 2659.9X_2 \geq 15000$

Belgium : $23.1X_1 + 36.9\,X_4 \geq 10000$

Ecuador : $40\,X_1 + 1160.5\,X_2 \leq 450$

Netherlands : $35.8\,X_4 \geq 20000$

Australia : $303.5X_4 \geq 50000$

Germany : $564.8\,X_4 \geq 6500$

Honduras : $576.2X_2 \leq 1000$

Ivory Coast : $32.5\,X_3 \leq 830$

Chile : $4008.1\,X_2 \geq 6800$

Colombia : $370.2\,X_2 \leq 50$

Italy : $1016.1X_4 \geq 15$

where $X_1, X_2, X_3, X_4 \geq 0$ (6)

Equation (5) above shows the total food import value, which is also known as the total food import price for the vegetables, fruits, nuts, and grains in the year 2017 was 12670.5 million $, 18,384.6 million $, 9066.7 million $, and 11257.6 million $, respectively. The first constraint in Equation (6) shows the total food volume for the group B food category where 11,070.2 thousand mt of vegetables, 13,606.2 thousand mt of fruits, 550.8 thousand mt of nuts, and 11,854.3 thousand mt of grains imported to the U.S. The others in Equation (6) represent the total food value which is also known as the price for the group B food category imported from different countries in the U.S..

Moreover, to know the total profit earned from the year 2017 to the year 2022 for food group C, the linear programming models were modelled, where X_1 represents sugar and candy, X_2 represents vegetable oils, X_3 represents cocoa and chocolate, and X_4 represents for the other edible products. Z in the objective function was used to define the total profits earned from the four food categories. Therefore, below is a linear programming model in the year 2017 for the group C food category.

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$$\text{Maximize } Z = 9066.7 + 7216X_2 + 5012.6X_3 + 10871.7X_4 \quad (7)$$

Subject to

Food Volume : $550.8\,X_1 + 6399.9X_2 + 1454.2\,X_3 + 2250.1\,X_4 \geq 12000$

Canada : $306.7\,X_1 + 2452.9X_2 + 2908.9\,X_3 + 1607.3\,X_4 \geq 6800$

Mexico : $1284.6\,X_1 + 136.3X_2 + 1083.7\,X_3 + 621.8\,X_4 \leq 65$

Indonesia : $3709.2\,X_2 + 305.1X_3 + 38.8\,X_4 \geq 4600$

India : $230.5\,X_1 + 143.3X_2 + 902.9\,X_4 \geq 3500$

Argentina : $40.9\,X_1 + 86.4X_2 + 115.6X_4 \leq 280$

China : $169.2\,X_1 + 3.4X_2 + 929.8\,X_4 \leq 50$

Malaysia : $1364.8\,X_2 + 250.7\,X_3 \leq 830$

New Zealand : $30.8\,X_4 \geq 20000$

Germany : $135.3\,X_3 + 271.9X_4 \leq 450$

Brazil : $116.9\,X_1 + 120X_4 \geq 7800$

Belgium : $156.8\,X_3 \geq 10000$

Netherlands : $379.5\,X_3 \geq 70$

Australia : $17.8X_4 \geq 50000$

Ireland : $2264.3X_4 \leq 1000$

Bulgaria : $18.3X_2 \leq 55$

Colombia : $13.2\,X_2 \leq 520$

France : $382.5\,X_4 \geq 9000$

Greece : $43.4\,X_2 \geq 6500$

Japan : $38.3X_2 \geq 15$

where $X_1, X_2, X_3, X_4 \geq 0$ (8)

Equation (7) shows the total food import value which is also known as the total food import price for group C category in the year 2017 was 9,066.7 million $, 7216 million $, 5,012.6 million $, and 10,871.7 million $. The first constraint in Equation (8) shows the total food volume for the group C food category where 550.8 thousand mt of sugar and candy, 6399.9 thousand mt of vegetable oils, 1,454.2 thousand mt of cocoa and chocolate, and 2250.1 thousand mt of other edibles products imported to the U.S. The others in Equation (8) represents the total food value which is also known as the price for the group C food category imported from different countries in the U.S..

Last but not least, to calculate the total profit earned from the year 2017 to the year 2022 for the group D food category, the linear programming models were constructed, where X_1 represents dairy, X_2 represents coffee, tea, and spices, and X_3 represents beverages. Z in the objective function was used to define the total profits earned from these three food categories. Therefore, below is a linear programming model in the year 2017 for the group D food category.

$$\text{Maximize } Z = 1876.9 + 11257.6X_2 + 15218.6X_3 \quad (9)$$

Subject to

Food Volume : $382.3\,X_1 + 2276.2X_2 + 8234\,X_3 \geq 12000$

Canada : $258.9\,X_1 + 1274.3X_2 + 692.6\,X_3 \leq 50$

France : $380.5\,X_2 + 1.6X_2 + 5825.8\,X_3 \geq 3500$

Italy : $606.6\,X_1 + 107.4\,X_2 + 4361\,X_3 \geq 20000$

Germany : $5.6\,X_1 + 169.5\,X_3 \geq 4600$

Ireland : $291.1\,X_1 + 809.4\,X_3 \leq 65$

Chile : $26.2\,X_1 + 282.1\,X_3 \leq 520$

Colombia : $2671.3X_2 \geq 9000$

Guatemala : $671.4\,X_2 \leq 1000$

Australia : $841.7X_3 \geq 50000$

Austria : $1752.7X_3 \geq 10000$

Belgium : $300.2X_3 \geq 7800$

Argentina : $309.2X_3 \leq 280$

Brazil : $2331.7X_2 \geq 6800$

China : $282X_2 \geq 15000$

Honduras : $294.9X_2 \leq 710$

Indonesia : $243.6\,X_2 \leq 830$

where $X_1, X_2, X_3 \geq 0$ (10)

Equation (9) shows the total food import value, which is also known as the total food import price for food group D in the year 2017, which was 1,876.9 million $, 11,257.6 million $, and 15,218.6 million $. The first constraint in Equation (10) shows the total food volume for the group D food category where 382.3 thousand mt of dairy, 2,276.2 thousand mt of coffee, tea, and spices, and 8,234 thousand mt of beverages imported to the U.S. The others in Equation (10) represent the total food value which is also known as the price for the food group D imported from different countries in the U.S.

3. Results and Discussion

The study investigates the optimal solution for the supply chain problems in food industry management by developing a linear programming model. Below are the results and discussion obtained by applying linear programming as an operational research technique.

3.1 Profit Earned for Group A Food Category in the U.S. the Year 2017 to Year 2022

Table 3 shows the total profit earned for group A food category imported from different countries by year. The highest total profit earned was in the year 2020, which was 104.23%, which is more than 100%. The U.S. earned the least profit in the year 2022, which was only approximately 2.72% of the total profit. Then, we created the graph using the data below, shown in Fig. 1.

Table 3 *Total profit earned for group A food category imported from different countries by year*

Year	Total Profit Earned (%)
2017	30.95580512
2018	46.79786143
2019	63.4318105
2020	104.2270837
2021	8.359442457
2022	2.716047662

Fig. 1 shows the graph of the total profit earned from group A food category against the year from the year 2017 to the year 2022. There is a slight increase in the total profit earned from the year 2017 to the year 2019. From the year 2019 to the year 2020, the total profit earned continued to increase until it became the highest total profit earned. The total profit earned started to decrease from the year 2020 to the year 2022. This is due to the large inflation of economics in these three years [10]. It caused the food value of the group A food category to increase from the year 2020 until the year 2022, and the total price the U.S. paid to food suppliers also increased.

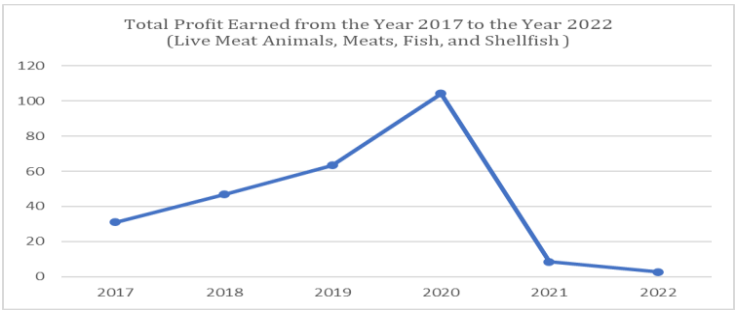

Fig. 1 *Graph of total profit earned for group A food category from 2017 to 2022*

3.2 Profit Earned for Group B Food Category in the U.S. the Year 2017 to Year 2022

Table 4 shows the group B food category imported from different countries by year. The highest total profit earned was in the year 2022, which was approximately 0.0494%. The U.S. earned the least profit in the year 2021, earning only approximately 0.0171% of the total profit. The details are shown in Table 4.

Table 4 *Total profit earned for group B food category imported from different countries by year*

Year	Total Profit Earned (%)
2017	0.041509434
2018	0.023968499
2019	0.022534849
2020	0.019990861
2021	0.017061935
2022	0.049370842

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Fig. 2 shows the graph of the total profit earned from group B food category from the year 2017 to the year 2022. The total profits earned continue to decrease from the year 2018 to the year 2021. From the year 2021 to the year 2022, the total profit earned slightly increased back. This is due to the inflation of economics in the year 2019 and the year 2020 [11]. It caused the food value of the group B food category to go up in the year 2019 to the year 2020, and the total price the U.S. paid to food suppliers also increased.

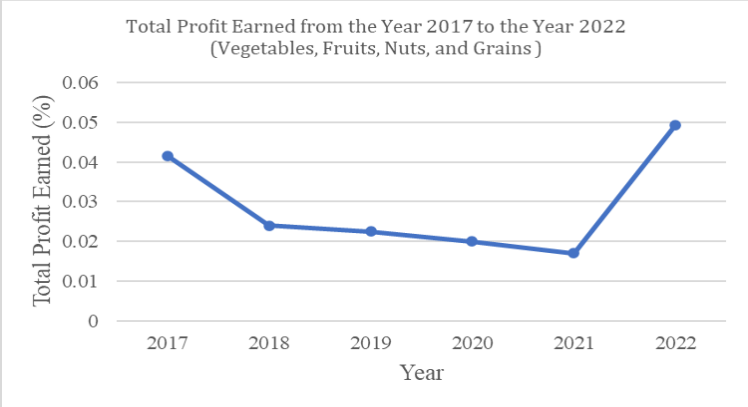

Fig. 2 *Graph of total profit earned for group B food category from 2017 to 2022*

3.3 Profit Earned for Group C Food Category in the U.S. the Year 2017 to Year 2022

Table 5 shows the total profit earned for group C food category imported from different countries by year. The highest total profit earned was in the year 2017, which was approximately 0.4769%. Table 3 also clearly states that the U.S. earned the least profit in the year 2022, earning only approximately 0.1839% of total profit. The details for the year 2017 are shown in Table 5.

Table 5 *Total profit earned for group C food category imported from different countries by year*

Year	Total Profit Earned (%)
2017	0.476889215
2018	0.251351137
2019	0.338718082
2020	0.249042146
2021	0.243628186
2022	0.183927561

Fig. 3 shows the graph of the total profit earned from group C food category from the year 2017 to the year 2022. The total profits earned decreased from the year 2017 to the year 2018. There is a slight increase in the total profit earned from the year 2018 to the year 2019. The total profits earned decreased from the year 2019 to the year 2022.

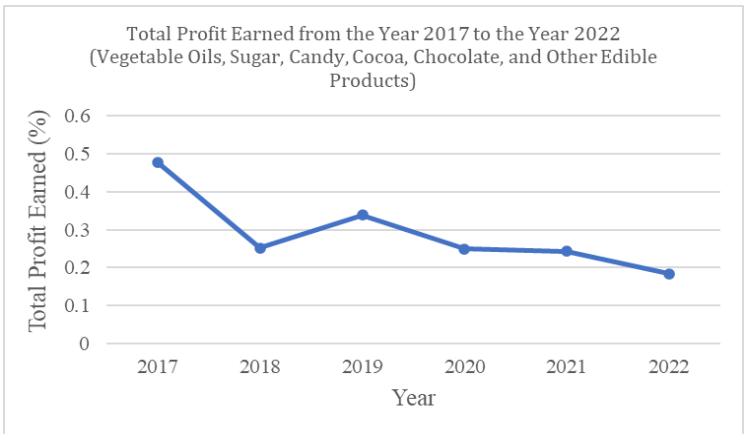

Fig. 3 *Graph of total profit earned for group C food category from 2017 to 2022*

3.4 Profit Earned for Group D Food Category in the U.S. the Year 2017 to Year 2022

Table 6 shows the group D food category imported from different countries by year. The highest total profit earned was in the year 2018, which was approximately 3.4440%. The U.S. earned the least profit in the year 2017, earning only approximately 0.0722% of the total profit. The details are shown in Table 6.

Table 6 *Total profit earned for group D food category imported from different countries by year*

Year	Total Profit Earned (%)
2017	0.072191741
2018	3.444005695
2019	2.968833658
2020	2.934801676
2021	1.719878908
2022	1.640279922

Fig. 4 shows the graph of the total profit earned from group D food category from the year 2017 to the year 2022. The total profits earned increased from the year 2017 to the year 2018. There is a slight decrease in the total profit earned from the year 2018 to the year 2019. The total profits earned continued to decrease from the year 2019 until the year 2022. This is because the food value of the group D food category increased from the year 2019 to the year 2022. It caused the U.S. to pay higher food value to food suppliers from different countries.

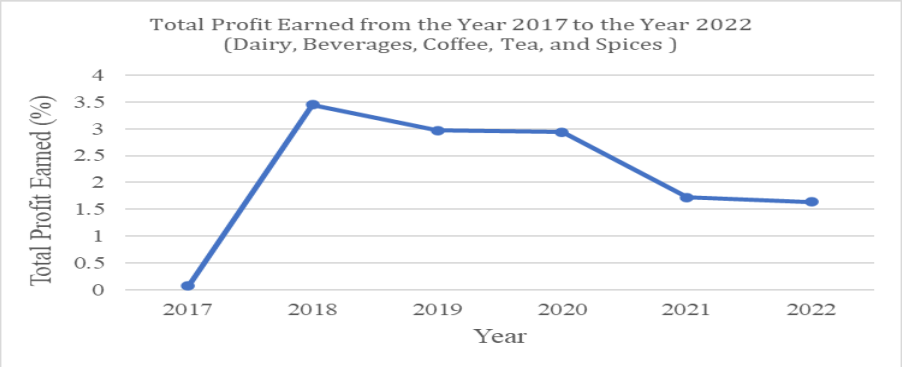

Fig. 4 *Graph of total profit earned for group D food category from 2017 to 2022*

3.5 Total Food Value and Food Volume for Different Categories of Foods

Table 7 clearly states that for the food value variable, the highest summation of food value from the fourteen food categories from the year 2017 to the year 2022 was the fish and shellfish category, which was approximately 148,145.6 million dollars $. The U.S. earned a profit of approximately 129,482.4 million $ from the fruits, which was the second highest ranked. The other edible products category was ranked in the third position for its food value from the fourteen food categories, which was recorded as 106,184.1 million $. The lowest value for summation of food value was the live meat animals' category, which was approximately 13,265.7million $.

Additionally, Table 7 also clearly states that the U.S. has the largest food volumes from the year 2017 to the year 2022, with approximately 85,750.2 thousand mt of fruits. The U.S. obtained approximately 72,225.0 thousand mt of vegetables, which was ranked at the second highest position of food volume compared with the fourteen food categories. The grains category was ranked the third highest for food volume, recorded as 71,236.8 thousand mt. Last but not least, the dairy category contributed the lowest summation of food volume, which was only 2,367.0 thousand mt from all food categories.

Fig. 5 clearly shows that the food volume was higher than the food value of live meat animals, vegetables, fruits, grains, vegetable oils, and sugar. This is because the point of the line graph, which shows the summation of food volume for these few food categories was slightly higher than the edge of the bar graph, which represents the food value for the same food categories.

Other than that, for the other categories of foods except those stated above, the food volume was lower than the food value. This is due to the point of the line graph, which shows the summation of food volume being slightly lower than the edge of the bar graph, which represents the food value.

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Table 7 *Summation of food value by the categories of foods*

Categories of Food	Food Value (million $)	Food Volume (thousands mt)
Live meat animals	13,265.7	45,599.9
Meats	65,429.4	11,623.3
Fish and shellfish	148,145.6	17,196.6
Dairy	13,457.4	2,367.0
Vegetables	88,247.2	72,225.0
Fruits	129,482.4	85,750.2
Nuts	18,893.6	3,320.9
Coffee, tea, and spices	57,094.2	13,898.0
Grains	85,505.6	71,236.8
Vegetable oils	49,642.4	38,962.6
Sugar and candy	32,692.0	27,006.1
Cocoa and chocolate	31,444.3	8,660.1
Other edible products	106,184.1	17,215.2
Beverages	98,543.3	51,143.8

Apart from that, the volume of the grains category was also high, although its food value was slightly high. This is due to people's high demand since they need to gain carbohydrates from the grains. Grains are one of the most important elements that people require to survive. Thus, the U.S. needs to buy grains from different suppliers to increase the amount of grains to achieve that demand. Some of the suppliers may import the grains at higher prices. Therefore, it causes the food value of grains to become slightly higher compared to the other categories of foods.

In conclusion, it was clearly shown that the volume of vegetables and fruits categories was higher, and its food value was lower. This is because vegetables and fruits are the most important foods and elements that are required by humans to be healthier. Since people eat vegetables and fruit every day, the demand for vegetables and fruits has always been higher. To fulfil this demand, the U.S. needs to buy more vegetables and fruits from different countries to increase the amount of vegetables and fruits daily.

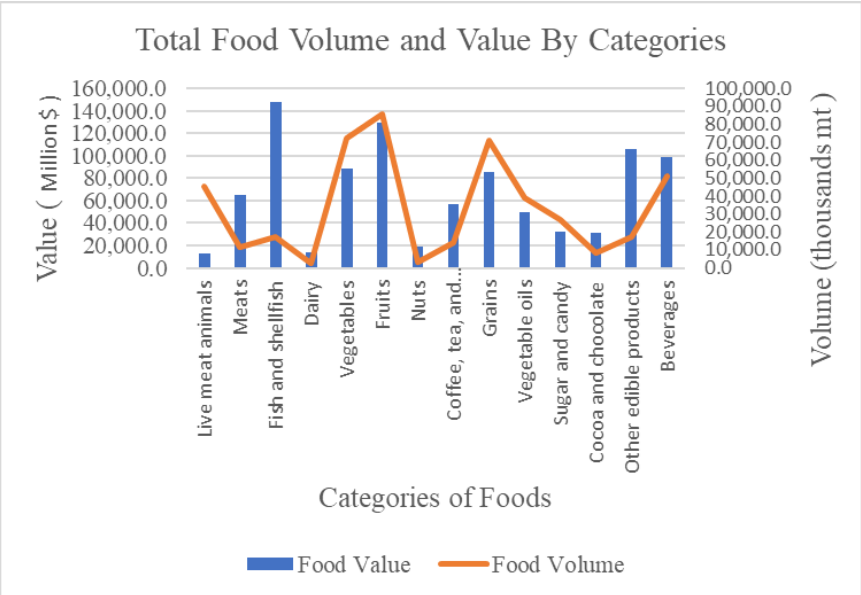

Fig. 5 *Graph of the total food value and food volume against the categories of foods from the year 2017 to the year 2022*

4. Conclusion

From this study, we know that the U.S. gained the highest profits from the group A food category in the year 2020, which was 104.23%. The U.S. earned the least profit in the year 2022 from the group A food category, which was only approximately 2.72% of the total profit. Not only that, by comparing the profits earned from the group B food category from the year 2017 to the year 2022, the U.S. earned the highest total profit in the year 2022, which was approximately 0.0494%. It earned the least profit in the year 2021, earning only approximately 0.0171% of the total profit.

Then, the U.S. gained the highest total profit in the year 2017 from the group C food category, which was approximately 0.4769%. It earned the least profit in the year 2022, earning only approximately 0.1839% of total profit. Lastly, by comparing the profits earned from the group D food category from the year 2017 to the year 2022, the highest total profit earned was in the year 2018, which was approximately 3.4440%. It earned the least profit in the year 2017, earning only approximately 0.0722% of the total profit.

In conclusion, the linear programming method is an effective and useful tool or method for an industry to manage its applications or processes of the supply chain. It can effectively save more time and help choose the most suitable method in supply chain management based on their needs and requirements.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the paper's publication. Our work has not been unduly influenced by any financial or personal relationships with individuals or organizations. The research presented in this paper has been conducted impartially, and the results are reported objectively.

Author Contribution

The authors confirm their contribution to the paper as follows: ***study conception and design****: Kok Zheng Yu, Cik Sri Mazzura Muhammad Basri;* ***analysis and interpretation of results****: Kok Zheng Yu;* ***validation of results****: Sri Mazzura Muhammad Basri;* ***draft manuscript preparation****: Kok Zheng Yu. All authors reviewed the results and approved the final version of the manuscript. They have agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.*

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