Mathematics Letters, eISNN: 2948-3735, 1 (2): 359-373, 2022

ANALYSIS OF KEY SUCCESS FACTORS OF FOOD DELIVERY APPLICATIONS BASED ON FUZZY DEMATEL APPROACH

Ainur Umairah Abdul Hakim[1], **Roselah Osman**[2*]

Maizatul Aqmar Amiruddin[3] , **Nazirah Ramli**[4]

[1,2,3]*Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*

[4]*Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Cawangan Pahang, 26400 Bandar Jengka, Pahang, Malaysia*

[1]ainurhakim101@gmail.com, [2*]roselah@tmsk.uitm.edu.my
[3]maizatul.aqmar@gmail.com, [4]nazirahr@uitm.edu.my
(indicates the corresponding author)*

ABSTRACT

Due to the COVID-19 pandemic, the Malaysian government issued a "Movement Control Order," or MCO. This limited the number of physical meetings, which meant that many common activities had to be done electronically or online. One industry that uses technology to take customer orders and deliver food is the food industry. Thus, it resulted in the development of the Food Delivery Application (FDA). To determine which components of the FDA should be improved, a detailed analysis of the FDA and the identification of the most key success factor are required. Multi-Criteria Decision-Making (MCDM) is being widely applied by researchers to solve a number of issues involving several criteria. This study recommends a fuzzy DEMATEL method for determining the interrelations between the FDA's success factors, their effects on one another, and the most important criteria. The study will consider the six factors chosen by experts as the most significant. Nine FDA experts made decisions based on a pairwise comparison of the criteria to be considered in the DEMATEL method. Among the six factors analyzed, the case study reveals that the three most important are the user Payment System (C3), Customer Service (C5), and Security (C2). Security (C2) and Delivery (C4) are the cause groups, whereas Information Quality (C1), Payment System (C3), Customer Services (C5), and Food Quality (C6) are the outcome groups. The study suggested that this method and other MCDM techniques be used together in the future to evaluate and choose an option based on criteria that have already been set.

Keywords: *Food Delivery Application (FDA), Fuzzy DEMATEL, Multi-Criteria Decision-Making (MCDM), COVID-19*

Received for review: 15-09-2022; Accepted: 29-09-2022; Published: 01-11-2022

1. Introduction

The Movement Control Order (MCO) that has been in effect since mid-March 2020 has forced many companies, including restaurants, cafes, bakeries, and convenience stores, to close or dissolve (Liang, 2020). People are concerned about this issue since it has a significant impact on their daily activities. Due to MCO regulations, physical meetings have been restricted to prevent the spread of COVID-19. According to Harun (2020), the gazette stated that persons travelling through an infected area or from one contaminated location to another to obtain food, groceries, medications, or nutritional supplements must adhere to "movement requirements." People will find it more difficult to purchase food, groceries, and other basics as a result of this.

However, people nowadays are lucky to live in an age of advanced technology, such as the internet and electronic devices. It is indisputable that technology assists them in a variety of ways. The advancement of modern technologies assisted them in surviving the pandemic. For example, food delivery apps (FDA) help ease the difficulty people have in obtaining food and goods during this pandemic. A food delivery app is a platform with a list of food prices or menus from restaurants, grocery stores, and other places to eat.

Between 753 B.C. and in 476 A.D., Ancient Rome had its first food delivery service (Factor, 2020). The concept of the service back then was similar to today's drive-through version, where they could get a hot and ready-to-eat meal on the go. Thermopolium was the name of their fast-food restaurant. During such periods, however, the amount of food given to customers is limited. With the advancement of technology, there were more options for customers to decide from, and the ordering procedure became simpler.

Customers can easily place an order and have it delivered to their home due to the fact that this meal delivery service is a smartphone app. So, the fact that the Food Delivery Application is available is convenient for customers, especially when they have to stay home because of the COVID-19 pandemic.

This research aims to rank the degree of influence of the factor in the key success factors of Food Delivery Application as well as to determine the interrelations between FDA success factors. Due to the arbitrary and subjective character of human assessments, fuzzy DEMATEL is used. Since human judgments are vague, imprecise, and subjective, Zadeh (1965) proposed a fuzzy set theory to overcome this problem to evaluate the success factors of FDA. By using the fuzzy concept, human judgments were turned into a fuzzy number from the influence score. In fuzzy set theory, interval sets are utilized as opposed to real numbers. It helps in the decision making as a human cannot exactly classify objects into different classes. Thus, we decide to analyze the data using fuzzy DEMATEL.

2. Methodology

The project aims to rank the degree of influence of each factor in the Food Delivery Application (FDA) key success factors and to determine the cause-and-effect relationships between the factors. Based on the research conducted by Zulkarnain et al. (2015), FDA researchers identified six critical success indicators. These indicators are listed in Table 2.1 with a brief description and a visual representation in Figure 2.2. The flow charts for the methodology are shown in Figure 2.1.

Table 2. 1 Key success factors of FDA, description, and representation

	Factors	**Description**	**Representation**
1	Information Quality	Information provided by FDA is well explained	C1
2	Security	Users believe their private information is kept well by the FDA	C2
3	Payment System	FDA accepts convenient payment methods such	C3
4	Delivery	Delivering food to users or businesses in a safe, timely manner.	C4
5	Customer Service	Help customers with complaints and questions,	C5
6	Food Quality	Food delivered are fresh, healthy,well presented, and cooked	C6

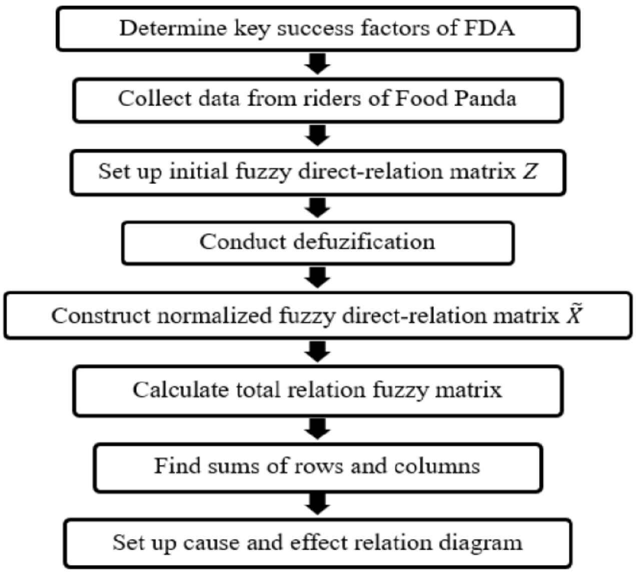

Figure 2. 1 Flow charts of methodology

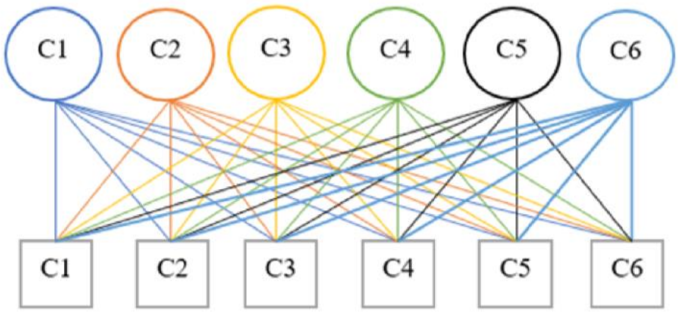

Figure 2. 2 Cause-and-effect diagrams

The computational procedure of the fuzzy DEMATEL method is described as follows.

STEP 1: Determine the success factors and construct the fuzzy linguistic scale.

The fuzzy linguistic scale (Deng et al., 2015) consists of a triangular fuzzy number, and linguistic terms: No influence, Very low influence, Low influence, High influence, and Very high influence. Each linguistic term will be displayed in a positive triangular fuzzy number (l_{ij}, m_{ij}, u_{ij}) as shown in Table 2.2.

Table 2.2 Fuzzy linguistic scale

Linguistic terms	**Triangular fuzzy number**
No influence	(0,0,0.25)
Very low influence	(0,0.25,0.50)
Low influence	(0.25,0.50,0.75)
High influence	(0.50,0.75,1)
Very high influence	(0.75,1,1)

STEP 2: Develop the initial fuzzy direct-relation matrix $\tilde{Z}$.

An initial fuzzy direct-relation matrix $\tilde{Z}$ is set up from the data gathered from the respondents. The evaluation criterion is expressed as $\{C_i \mid i = 1, 2, \ldots, n\}$. The initial fuzzy direct-relation matrix $\tilde{Z}$ by having the respondent's conduct in this research is as follows:

$$\tilde{Z} = \begin{array}{c} C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{bmatrix} 0 & \tilde{Z}_{12} & \cdots & \tilde{Z}_{1n} \\ \tilde{Z}_{21} & 0 & \cdots & \tilde{Z}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{Z}_{n1} & \tilde{Z}_{n2} & \cdots & 0 \end{bmatrix} \tag{1}$$

Note that $\tilde{Z}_{ij} = (l_{ij}, m_{ij}, u_{ij})$, which represents lower bound (l), middle bound (m), and upper bound (u) of the triangular fuzzy number. Besides, $\tilde{Z}_{ij}, i = 1, 2, \ldots, n$ on the diagonal is $(0, 0, 0)$.

STEP 3: Conduct defuzzification.

The best non-fuzzy performance value (BNP) method is used for the defuzzification of values.

The fuzzy numbers can be defuzzified to obtain the total-relation matrix by using this formula, The fuzzy numbers can be defuzzified to obtain the total-relation matrix by using this formula,

$$\frac{[(u_{ij} - l_{ij}) + (m_{ij} - l_{ij})]}{3} + l_{ij} \tag{2}$$

The matrix after defuzzification is denoted as T, $t_{ij} \in T$,

$$T = [t_{ij}], \quad i, j = \{1, 2, \ldots, n\} \tag{3}$$

STEP 4: Construct normalized fuzzy direct-relation matrix $\tilde{X}$.

The criteria scale was transformed into comparable scales by using a normalization formula. The fuzzy linguistic variable is converted into influence scores. Having:

$$\tilde{a}_{ij} = \sum_{j=1}^{n} \tilde{Z}_{ij} = \left(\sum_{j=1}^{n} l_{ij}, \sum_{j=1}^{n} m_{ij}, \sum_{j=1}^{n} u_{ij} \right) \quad and \quad r = \max_{1 \le i \le n} \left(\sum_{j=1}^{n} u_{ij} \right) \tag{4}$$

The normalized fuzzy direct-relation matrix is:

$$\tilde{X} = \begin{bmatrix} \tilde{X}_{11} & \tilde{X}_{12} & \cdots & \tilde{X}_{1n} \\ \tilde{X}_{21} & \tilde{X}_{22} & \cdots & \tilde{X}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{X}_{m1} & \tilde{X}_{m2} & \cdots & \tilde{X}_{mn} \end{bmatrix} \quad and \quad \tilde{X}_{ij} = \frac{\tilde{Z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right) \tag{5}$$

STEP 5: Setting up the fuzzy total-relation matrix.

Once the normalized directed-relation matrix $\tilde{X}$ is produced, the fuzzy total-relation matrix $\tilde{T}$can be constructed from the following formulae:

$$\begin{aligned} \tilde{T} &= \tilde{X} + \tilde{X}^2 + \cdots + \tilde{X}^k \\ &= \tilde{X}\left(I + \tilde{X} + \tilde{X}^2 + \cdots + \tilde{X}^{k-1}\right) \\ &= \tilde{X}\left(I + \tilde{X} + \tilde{X}^2 + \cdots + \tilde{X}^{k-1}\right)\left(1 - \tilde{X}\right)\left(1 - \tilde{X}\right)^{-1} \\ &= \tilde{X}\left(1 - \tilde{X}\right)^{-1}, \quad when \lim_{k \to \infty} \tilde{X}^k = [0]_{n \times n} \end{aligned} \tag{6}$$

$$\begin{aligned} \left[l''_{ij}\right] &= X_l \times (I - X_l)^{-1} \\ \left[m''_{ij}\right] &= X_m \times (I - X_m)^{-1} \\ \left[u''_{ij}\right] &= X_u \times (I - X_u)^{-1} \end{aligned} \tag{7}$$

$$\tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \tilde{t}_{12} & \cdots & \tilde{t}_{1n} \\ \tilde{t}_{21} & \tilde{t}_{22} & \cdots & \tilde{t}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{t}_{m1} & \tilde{t}_{m2} & \cdots & \tilde{t}_{mn} \end{bmatrix} \quad and \quad \tilde{t}_{ij} = \left(l''_{ij}, m''_{ij}, u''_{ij}\right) \tag{8}$$

Where $X_l, X_m, X_u X_l, X_m, X_u$ are influence matrices from $\tilde{X}$, and I is an identity matrix.

STEP 6: Calculate the row summation and the column summation.

The sum of row i is denoted as a vector R_i which indicates the influential levels of i factor on all other factors, whereas the sum of the column j is denoted as vector C_j, which indicates the influenced levels of j factor.

The symbol of summation:

$$R_i = \left[\sum_{i=1}^{n} t_{ij}\right]_{n\times 1} ; C_j = \left[\sum_{j=1}^{n} t_{ij}\right]_{1\times n} \tag{9}$$

denote the sum of the row and the sum of the column, respectively.

STEP 7: Draw a cause-effect diagram.

In this step, the prominence $(R_i + C_j)$ and the relation $(R_i - C_j)$ are computed. A factor is considered in the cause group if $(R_i - C_j)$ is positive. However, the factors belong to the effect group if $(R_i - C_j)$ is negative. Thus, the causal diagram can visualize the complex causal relationship by mapping the data set of $(R_i + C_j, R_i - C_j)$

3. Implementation

STEP 1: Determine the success factors and construct the fuzzy linguistic scale.

The responses of FDA experts are then recorded in language terms, as shown in Table 2.2, on a five-point fuzzy linguistic scale of "No Influence," "Low Influence," "Normal Influence," "High Influence," and "Very High Influence." Tables 2.3 and 2.4 provide samples of responses from Experts 1 and 2, respectively, and Table 2.5 shows samples from Expert 3.

Table 2.3: Expert 1

	C1	**C2**	**C3**	**C4**	**C5**	**C6**
C1	0	H	H	L	H	L
C2	H	0	VH	L	H	L
C3	VH	H	0	L	H	H
C4	H	H	VH	0	H	H
C5	H	H	VH	L	0	H
C6	VH	H	VH	L	H	0

Table 2.4: Expert 2

	C1	**C2**	**C3**	**C4**	**C5**	**C6**
C1	0	H	H	H	H	H
C2	L	0	H	H	H	H
C3	H	VH	0	H	H	H

C4	H	VH	H	0	H	H
C5	H	H	H	H	0	H
C6	H	H	H	H	H	0

Table 2.5: Expert 3

	C1	**C2**	**C3**	**C4**	**C5**	**C6**
C1	0	VL	L	L	L	H
C2	L	0	VL	VL	L	L
C3	L	L	0	L	L	H
C4	H	VL	L	0	L	L
C5	VL	L	L	VL	0	L
C6	H	H	L	L	L	0

STEP 2: Develop the initial fuzzy direct-relation matrix $\tilde{Z}$.

The linguistic terms from Step 1 are next converted into fuzzy numbers in accordance with Table 2.2. The initial fuzzy direct-relation matrix for Expert 1, Expert 2, and Expert 3 is shown below.

Expert 1

$$\tilde{Z} = \begin{bmatrix} (0,0,0) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.25,0.50,0.75) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0,0,0) & (0.75,1.00,1.00) & (0.25,0.50,0.75) & (0.50,0.75,1.00) & (0.25,0.50,0.75) \\ (0.75,1.00,1.00) & (0.50,0.75,1.00) & (0,0,0) & (0.25,0.50,0.75) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.75,1.00,1.00) & (0,0,0) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.75,1.00,1.00) & (0.25,0.50,0.75) & (0,0,0) & (0.50,0.75,1.00) \\ (0.75,1.00,1.00) & (0.50,0.75,1.00) & (0.75,1.00,1.00) & (0.25,0.50,0.75) & (0.50,0.75,1.00) & (0,0,0) \end{bmatrix}$$

Expert 2

$$\tilde{Z} = \begin{bmatrix} (0,0,0) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.25,0.50,0.75) & (0,0,0) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0.75,1.00,1.00) & (0,0,0) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0.75,1.00,1.00) & (0.50,0.75,1.00) & (0,0,0) & (0.50,0.75,1.00) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0,0,0) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0,0,0) \end{bmatrix}$$

Expert 3

$$\tilde{Z} = \begin{bmatrix} (0,0,0) & (0,0.25,0.50) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0.50,0.75,1.00) \\ (0.25,0.50,0.75) & (0,0,0) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0.25,0.50,0.75) \\ (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0,0,0) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0.50,0.75,1.00) \\ (0.50,0.75,1.00) & (0,0.25,0.50) & (0.25,0.50,0.75) & (0,0,0) & (0.25,0.50,0.75) & (0.25,0.50,0.75) \\ (0,0.25,0.50) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0,0.25,0.50) & (0,0,0) & (0.25,0.50,0.75) \\ (0.50,0.75,1.00) & (0.50,0.75,1.00) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0.25,0.50,0.75) & (0,0,0) \end{bmatrix}$$

STEP 3: Conduct defuzzification. Find the centroid number.

$$C_{ij} = \frac{[(u_{ij} - l_{ij}) + (m_{ij} - l_{ij})]}{3} + l_{ij}$$

Based on the value of $\tilde{Z}_{ij}$ from Expert 1:

$$\tilde{Z}_{12} = (0.50, 0.75, 1.00)$$

$$\tilde{Z}_{24} = (0.25, 0.50, 0.75)$$

$$\tilde{Z}_{31} = (0.75, 1.00, 1.00)$$

Centroid number is then calculated using the formula as shown below:

$$C_{12} = \frac{[(1.00 - 0.50) + (0.75 - 0.50)]}{3} + 0.50 = 0.7500$$

$$C_{24} = \frac{[(0.75 - 0.25) + (0.50 - 0.25)]}{3} + 0.25 = 0.5000$$

$$C_{31} = \frac{[(1.00 - 0.75) + (1.00 - 0.75)]}{3} + 0.75 = 0.9167$$

Then, we obtained the defuzzified value, T:

Expert 1:

$$T = \begin{bmatrix} 0.0000 & 0.7500 & 0.7500 & 0.5000 & 0.7500 & 0.5000 \\ 0.7500 & 0.0000 & 0.9167 & 0.5000 & 0.7500 & 0.5000 \\ 0.9167 & 0.7500 & 0.0000 & 0.5000 & 0.7500 & 0.7500 \\ 0.7500 & 0.7500 & 0.9167 & 0.0000 & 0.7500 & 0.7500 \\ 0.7500 & 0.7500 & 0.9167 & 0.5000 & 0.0000 & 0.7500 \\ 0.9167 & 0.7500 & 0.9167 & 0.5000 & 0.7500 & 0.0000 \end{bmatrix}$$

In similar manner, we obtained the defuzzified value for other experts as follows.

Expert 2:

$$T = \begin{bmatrix} 0.0000 & 0.7500 & 0.7500 & 0.7500 & 0.7500 & 0.7500 \\ 0.5000 & 0.0000 & 0.7500 & 0.7500 & 0.7500 & 0.7500 \\ 0.7500 & 0.9167 & 0.0000 & 0.7500 & 0.7500 & 0.7500 \\ 0.7500 & 0.9167 & 0.7500 & 0.0000 & 0.7500 & 0.7500 \\ 0.7500 & 0.7500 & 0.7500 & 0.7500 & 0.0000 & 0.7500 \\ 0.7500 & 0.7500 & 0.7500 & 0.7500 & 0.7500 & 0.0000 \end{bmatrix}$$

Expert 3:

$$T = \begin{bmatrix} 0.0000 & 0.2500 & 0.5000 & 0.5000 & 0.5000 & 0.7500 \\ 0.5000 & 0.0000 & 0.5000 & 0.5000 & 0.5000 & 0.5000 \\ 0.5000 & 0.5000 & 0.0000 & 0.5000 & 0.5000 & 0.7500 \\ 0.7500 & 0.2500 & 0.5000 & 0.0000 & 0.5000 & 0.5000 \\ 0.2500 & 0.5000 & 0.5000 & 0.2500 & 0.0000 & 0.5000 \\ 0.7500 & 0.7500 & 0.5000 & 0.5000 & 0.5000 & 0.0000 \end{bmatrix}$$

STEP 4: Construct normalized fuzzy direct-relation matrix $\widetilde{X}$.
Calculate the average defuzzified value for all $C_{i\,j}$.

$n = 9\ (number\ of\ experts)$

$$Average\ defuzzified\ value\ for\ C_{12} = \frac{\sum C_{12}\ for\ all\ experts}{n} \tag{10}$$

$$= \frac{0.7500 + 0.7500 + 0.2500 + 0.0833 + 0.7500 + 0.7500 + 0.7500 + 0.0833 + 0.2500}{9}$$

$= 0.4907$

Average defuzzified value:

	C1	C2	C3	C4	C5	C6	SUM OF ROW
C1	0.0000	0.4907	0.5926	0.5278	0.6019	0.5278	2.7407
C2	0.5556	0.0000	0.6389	0.5463	0.6111	0.5741	2.9259
C3	0.6759	0.6204	0.0000	0.5463	0.6296	0.6296	3.1019
C4	0.6019	0.5370	0.6389	0.0000	0.5833	0.5833	2.9444
C5	0.5463	0.5741	0.6111	0.5185	0.0000	0.5833	2.8333
C6	0.6019	0.5833	0.6204	0.5000	0.5278	0.0000	2.8333
							3.1019

*Summation of sum of rows = 3.1019

$$\tilde{X}_{12} = \frac{Average\ defuzzified\ value\ for\ C_{12}}{Summation\ of\ sum\ of\ rows} = \frac{0.4907}{3.1019} = 0.1582$$

In similar manner, we obtained the normalized fuzzy direct-relation matrix as follows:

$$\tilde{X} = \begin{bmatrix} 0.0000 & 0.1582 & 0.1910 & 0.1701 & 0.1940 & 0.1701 \\ 0.1791 & 0.0000 & 0.2060 & 0.1761 & 0.1970 & 0.1851 \\ 0.2179 & 0.2000 & 0.0000 & 0.1761 & 0.2030 & 0.2030 \\ 0.1940 & 0.1731 & 0.2060 & 0.0000 & 0.1881 & 0.1881 \\ 0.1761 & 0.1851 & 0.1970 & 0.1672 & 0.0000 & 0.1881 \\ 0.1940 & 0.1881 & 0.2000 & 0.1612 & 0.1701 & 0.0000 \end{bmatrix}$$

STEP 5: Setting up the fuzzy total-relation matrix.

Once the normalized directed-relation matrix $\tilde{X}$ is produced, the fuzzy total-relation matrix $\tilde{T}$ can be constructed from the following formulae.

$$\tilde{T} = \tilde{X}(I - \tilde{X})^{-1} \tag{11}$$

Identity matrix is described as below:

$$I = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

The matrix below is obtained from $I - \tilde{X}$.

$$I - \tilde{X} = \begin{bmatrix} 1.000 & -0.1582 & -0.1910 & -0.1701 & -0.1940 & -0.1701 \\ -0.1791 & 1.0000 & -0.2060 & -0.1761 & -0.1970 & -0.1851 \\ -0.2179 & -0.2000 & 1.0000 & -0.1761 & -0.2030 & -0.2030 \\ -0.1940 & -0.1731 & -0.2060 & 1.0000 & -0.1881 & -0.1881 \\ -0.1761 & -0.1851 & -0.1970 & -0.1672 & 1.0000 & -0.1881 \\ -0.1940 & -0.1881 & -0.2000 & -0.1612 & -0.1701 & 1.0000 \end{bmatrix}$$

Then, we computed $(I - \tilde{X})^{-1}$, and obtained the matrix below,

$$(I - \tilde{X})^{-1} = \begin{bmatrix} 3.1779 & 2.2060 & 2.4072 & 2.1073 & 2.3224 & 2.2708 \\ 2.4556 & 3.1887 & 2.5476 & 2.2249 & 2.4492 & 2.4043 \\ 2.5932 & 2.4600 & 3.4907 & 2.3245 & 2.5629 & 2.5244 \\ 2.4776 & 2.3468 & 2.5592 & 3.0854 & 2.4540 & 2.4173 \\ 2.3913 & 2.2859 & 2.4772 & 2.1625 & 3.2229 & 2.3457 \\ 2.4032 & 2.2869 & 2.4782 & 2.1574 & 2.3676 & 3.1863 \end{bmatrix}$$

Next, matrix $\tilde{T}$ is computed by $\tilde{X}(I - \tilde{X})^{-1}$,

$$\tilde{T} = \begin{bmatrix} 2.1779 & 2.2060 & 2.4072 & 2.1073 & 2.3224 & 2.2708 \\ 2.4556 & 2.1887 & 2.5476 & 2.2249 & 2.4492 & 2.4043 \\ 2.5932 & 2.4600 & 2.4907 & 2.3245 & 2.5629 & 2.5244 \\ 2.4776 & 2.3468 & 2.5592 & 2.0854 & 2.4540 & 2.4173 \\ 2.3913 & 2.2859 & 2.4772 & 2.1625 & 2.2229 & 2.3457 \\ 2.4032 & 2.2869 & 2.4782 & 2.1574 & 2.3676 & 2.1863 \end{bmatrix}$$

STEP 6: Calculate the row summation and the column summation.

The sum of row i is denoted as a vector R_i which indicates the influential levels of i factor on all other factors, whereas the sum of the column j is denoted as vector C_j, which indicates the influenced levels of j factor.

	C1	C2	C3	C4	C5	C6	ΣR_i
C1	2.1779	2.2060	2.4072	2.1073	2.3224	2.2708	13.4915
C2	2.4556	2.1888	2.5476	2.2250	2.4492	2.4043	14.2704
C3	2.5932	2.4600	2.4907	2.3244	2.5629	2.5243	14.9555
C4	2.4776	2.3468	2.5592	2.0854	2.4540	2.4173	14.3403
C5	2.3913	2.2859	2.4772	2.1625	2.2229	2.3457	13.8855
C6	2.4032	2.2869	2.4783	2.1574	2.3676	2.1863	13.8797
ΣC_j	14.4988	13.7743	14.9601	13.0620	14.3790	14.1488	

Table 3. 1 The degree of central role

	C1	C2	C3	C4	C5	C6
ΣR_i	13.4915	14.2704	14.9555	14.3403	13.8855	13.8797
ΣC_j	14.4988	13.7743	14.9601	13.062	14.379	14.1488
$R_i + C_j$	27.9903	28.0447	29.9156	27.4023	28.2645	28.0285
$R_i - C_j$	-1.0073	0.4961	-0.0046	1.2783	-0.4935	-0.2691

RANK:	C3 $\succ$ C5 $\succ$ C2 $\succ$ C6 $\succ$ C1 $\succ$ C4
CAUSE GROUP:	C2 & C4
EFFECT GROUP:	C1, C3, C5, C6

STEP 7: Draw a cause-effect diagram

In Figure 2.3, the causal diagram is formed by (R+C) on the horizontal axis and (R-C) the vertical axis. The value (R-C) divides the success factors of FDA into a cause group and an effect group. When the value of R-C is positive, it means that the factor is in the cause group, and if the R-C is negative, it means that the factor is in the effect group. The user should analyze the values of R-C to determine which criteria have an effect on each other. In addition, in the causal diagram shown in Figure 2.3, the factors are separated into the cause group, which includes Security (C2) and Delivery (C4), and the effect group, which includes Information Quality (C1), Payment System (C3), Customer Service (C5), and Food Quality (C6).

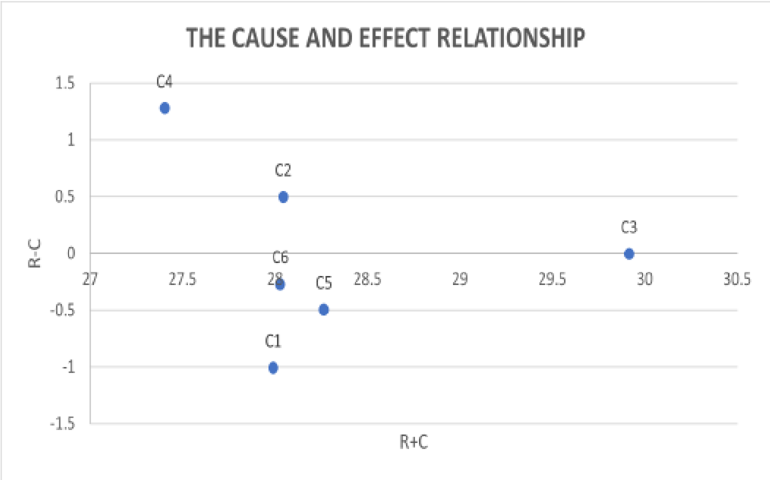

Figure 2.3 Cause-effect diagram

4. Results and Discussion

The DEMATEL method attempts to find a connection between the items on the list and determine what caused what. As a result, the DEMATEL method was utilised in this study to determine the weighted relevance of each factor in relation to each element and map the cause-level of each as shown in the causal diagram.

This study used the fuzzy DEMATEL method to investigate and determine the degree of influence of the success factors and the cause-and-effect relationships of the Food Delivery Application's key success criteria (FDA). The findings of this study indicate which factor has the greatest impact on the success of an FDA. The significant weights of the components were sorted according to their R+C values. The highest R+C value is 29.9156 for Payment System (C3), followed by 28.2645 for Customer Service (C5), 28.0447 for Security (C2), 28.0285 for Food Quality (C6), 27.9903 for Information Quality (C1), and 27.4023 for Delivery (C4). Therefore, the ordering of the component based on R+C values is the Payment System (C3) is the most important success component that contributes to the success of an FDA. Therefore, FDA should offer a range of online payment alternatives, including Cash on Delivery (COD), Cash/Debit Card, and PayPal. Next, the value of R-C is used to determine which factors belong to the category of causes or effects. Since both Security (C2) and Delivery (C4) have a positive R-C value, they are components of the cause group. However, when R-C is negative, the effect group includes Information Quality (C1), Payment System (C3), Customer Services (C5), and Food Quality (C6). Both factors in the cause and effect groups have a significant impact on the system. As a result of improving the cause factors, the impact elements will inevitably develop.

Enhancing the key success element C4, Delivery services, can also enhance the key success factor C1, Information Quality, by supplying the users with high-quality information. As delivery services are one of the aspects that determine the number of users for an application, listing all of the pertinent information about the benefits of the application, including delivery services, will assist the users in recognising their application. On the other hand, factors in the same group are related to one another. If FDA companies opt to increase their security, their delivery services will also benefit. Implementing a tracking system, for example, into their food delivery applications to ensure that all deliveries are delivered at the correct locations on time will surely grab FDA users' attention because they will be able to track their orders. Using the cause group's criteria, FDA companies can take efforts to improve their service based on the research findings. Security and delivery are two aspects of the FDA's operations that should be improved.

5. Conclusion and Recommendations

Numerous food delivery apps are now available as software or application systems. The only way to determine whether an application will be effective is to understand the aspects that will influence it. This study employs the DEMATEL approach to examine the most influential success factor of Food Delivery Applications (FDA). The results of this study will hopefully assist FDA companies in precisely predicting which success factor to prioritize and improving their strategies by focusing on the success factors used in this study. The parameters were examined by a council of experts, who are Food Panda's riders. Using the method used, all of the responses were put together, and then the total relationship matrix for each factor was found.

A success factor is any information, skill, personality, purpose, attitude, or other human quality that is essential to fulfil the task or role and that distinguishes solid from great performance. According to what we found, delivery is the success factor that affects other factors the most. It can assist FDA companies in securing and boosting the number of users utilizing their application by ensuring that their delivery service fulfils customer requirements. This study advises that more research be conducted to obtain comprehensive data in order to improve the cause-and-effect model. Future research is also proposed to apply additional Multi-Criteria Decision-Making (MCDM) methods in a fuzzy environment, such as Analytic Hierarchy Process (AHP) and TOPSIS, to examine the major success factor of Food Delivery Application and to compare the outcomes of these approaches.

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