Neutrosophic Soft Set with Application in Decision Making: A Case Study on Online Food Delivery

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Abstract: The global online food delivery (OFD) market has experienced significant growth, particularly accelerated by the COVID-19 pandemic. This surge is largely attributed to the convenience of ordering meals online and having them delivered directly to consumers' homes. Additional services offered by OFD platforms have proven essential in supporting social distancing efforts, expanding service accessibility, and minimising the gap between purchase and consumption. In Malaysia, the OFD sector has grown rapidly, presenting vast opportunities for various platforms while simultaneously intensifying market competition. To sustain this growth and adapt to evolving consumer demands, OFD providers must consider multiple strategic dimensions. This study aims to identify the most preferred OFD service among students at Universiti Teknologi MARA (UiTM) Kelantan Branch and to determine the most influential factors affecting their purchasing decisions. The neutrosophic soft set method is employed to analyse expert linguistic evaluations across six key parameters: delivery cost, delivery speed, convenience of payment, web design, marketing techniques, and order fulfillment. The findings reveal that Grab Food is the preferred OFD platform, outperforming Food Panda. Moreover, "convenience of payment" emerged as the most influential parameter driving students' decisions to use OFD services.

Keywords: Covid-19, Decision making, Neutrosophic soft set, Online food delivery

1 Introduction

Online food delivery (OFD) experienced rapid growth during the COVID-19 pandemic. According to Nguyen et al. (2021), OFD services were already benefiting from increasing digitalization even before the global spread of the virus. The rise of urban lifestyles in cities across various countries has further accelerated the expansion of the OFD market. Today, dining is no longer limited to takeaways or dining out – OFD has become a modern alternative to eating out. In Malaysia, major urban areas such as Kuala Lumpur, Johor Bahru, Klang Valley, and Penang have been key focus areas for OFD services due to their high population density and urban development. However, as noted by Chai and Yat (2019), OFD platforms face challenges related to delivery coverage and location constraints, unlike e-commerce services, which are more scalable with the support of third-party logistics providers. Yeo et al. (2017) highlighted that in 2012, Kentucky Fried Chicken (KFC) was a dominant player in the food delivery sector. Nevertheless, smaller food retailers have also shown strong interest in providing delivery services through partnerships with food delivery intermediaries. The global OFD market is projected to reach a value of US$200 billion by 2025.

OFD services offer numerous benefits to customers, including attractive deals, rewards, and discounts through their mobile applications. These platforms provide access to a wide range of restaurants and diverse meal options; all delivered conveniently to customers' doorsteps. Orders can be placed via phone, websites, mobile apps, or directly through a restaurant's own online system. Typically, customers pay a flat delivery fee, which may be waived based on the total value of their order. Since the COVID-19 outbreak, contactless delivery has become a standard practice, ensuring safety and convenience. As consumer preferences continue to shift toward online food purchasing, the OFD market has become increasingly competitive and challenging for existing providers. The growth of this sector, driven by service quality, technological innovations, and risk factors, has transformed how OFD companies engage with their customers. With dining-in restrictions during the pandemic, delivery services saw a revenue increase of up to 140%, while in-restaurant spending dropped by 35%.

The concept of uncertainty is complex and often not clearly defined, making it difficult for classical mathematics to adequately model problems involving uncertain data (Deli, 2017). To address this, various mathematical frameworks have been developed, including probability theory, fuzzy set theory, neutrosophic set theory, rough set theory, and other related tools. These approaches have been successfully applied in many real-world scenarios to manage and resolve uncertainty. Zadeh (1996) introduced the concept of fuzzy sets, which has since been widely used to solve numerous real-life problems in environments characterised by ambiguity and vagueness. Fuzzy set theory and fuzzy logic have become essential tools in fields such as engineering, medical diagnosis, and the social sciences.

However, assigning precise membership values in fuzzy sets can be challenging. Applications involving belief systems, expert systems, and information fusion often require consideration of both truth-membership and falsity-membership values, which fuzzy sets and interval-valued fuzzy sets may not adequately handle. To overcome this limitation, Atanassov (1999) introduced intuitionistic fuzzy sets, which account for incomplete information by incorporating degrees of truth, indeterminacy, and falsity, where the sum of these components equals one. Nonetheless, intuitionistic fuzzy sets fall short in handling inconsistent and indeterminate information. To address this gap, Smarandache (2005) proposed the neutrosophic set theory, where truth-membership, indeterminacy-membership, and falsity-membership are treated as independent components. This framework explicitly quantifies indeterminacy, allowing it to handle problems that intuitionistic fuzzy sets cannot solve. Thus, neutrosophic sets offer a more flexible and comprehensive approach to modelling uncertainty in complex systems.

Molodtsov (1999) introduced the concept of the neutrosophic soft set (NSS) as a tool to address complex problems and various forms of uncertainty. According to Deli (2017), neutrosophic soft set theory provides a mathematical framework for managing uncertainty through the lens of parameterisation. One of its key advantages is that it does not require the definition of a membership function, making it more adaptable and straightforward to apply across different problem domains. Maji (2013) further developed this concept by combining soft set theory with neutrosophic set theory to form the neutrosophic soft set, which has since been widely used in decision-making processes. Interest in soft sets has grown rapidly due to their versatility and effectiveness in numerous applications, including algebraic structures, data analysis, operations research, ontology, medical diagnosis, and decision-making under uncertainty. Çağman (2014) later enhanced the soft set model by introducing a single-parameter approach and compared it with earlier definitions, further refining its applicability and performance. Besides, Al-Hijjawi (2024) introduces the innovative concept of an effective neutrosophic soft expert set, meticulously crafted to encapsulate external influences on both neutrosophic soft sets and expert opinions within a unified model. In addition, Saeed (2025) formed a modified hybrid of soft set named Fermatean Neutrosophic Soft set (FrNSS) to establish an application of this hybrid structure to decision-making problems.

OFD industry has experienced rapid growth, accompanied by increasingly complex customer preferences and service performance criteria. Traditional decision-making approaches often fall short in accurately capturing the ambiguity, vagueness, and inconsistency inherent in human judgment particularly when evaluating multiple, conflicting criteria such as delivery speed, food quality,

convenience of payment, and customer satisfaction. In this context, neutrosophic theory emerges as a highly suitable framework. Unlike classical fuzzy sets or intuitionistic fuzzy sets, neutrosophic sets allow the representation of truth, indeterminacy, and falsity independently, thereby providing a more comprehensive and flexible model for dealing with uncertain and imprecise information. This is particularly essential in the OFD environment, where customer feedback and service assessments are often subjective, incomplete, or even contradictory. Applying neutrosophic theory thus enhances the robustness and reliability of the decision-making process, ensuring that the selected OFD service providers align more closely with consumer preferences and real-world uncertainties. So, this study aims to identify the optimal choice in decision-making process of OFD in neutrosohic environment by using NSS. This set is a combination of neutrosophic theory and soft set theory, to provide a flexible and powerful decision-making framework. NSS is particularly advantageous in this context because it allows each element's relationship with a parameter to be expressed in terms of truth-membership, indeterminacy-membership, and falsity-membership, while also accounting for the parametric structure of decision factors. This dual capability makes NSS a superior choice over traditional fuzzy or intuitionistic fuzzy models when dealing with real-world OFD selection problems under high uncertainty and conflicting opinions.

2 Preliminaries

This section presents the fundamental concepts of neutrosophic theory that form the basis for the decision-making methodology employed in this study.

Definition 1: A neutrosophic set A on the universe of discourse Y is defined as
$$A = \{\langle y, T_A(y), I_A(y), F_A(y)\rangle : y \in Y\}$$
where
$$T_A, I_A, F_A : Y \to]^-0, 1^+[\quad \text{and} \quad {}^-0 \le T_A(y) + I_A(y) + F_A(y) \le 3^+.$$

Definition 2: A neutrosophic soft set (NSS) f over Y is a function valued by neutrosophic set from E to $N(Y)$. It can be expressed in the form
$$f = \{(e, \{\langle y, T_{f(e)}(y), I_{f(e)}(y), F_{f(e)}(y)\rangle : y \in Y\}) : e \in E\}$$
where $N(Y)$ represents all neutrosophic sets over Y. Note that if $f(e) = \{\langle y, 0,1,1\rangle : y \in Y\}$, the element $(e, f(e))$ does not appear in the neutrosophic soft set f. Set of all NSS over Y is denoted by NS.

Definition 3: Let $Y = \{y_1, y_2, \dots, y_m\}$ be an initial universe, $E = \{e_1, e_2, \dots, e_n\}$ be a parameter set and f be a neutrosophic soft set over Y. According to the Saaty Rating Scale (Table 1), relative parameter matrix d_E is defined as follows:

$$d_E = \begin{bmatrix} 1 & d_E(e_1, e_2) & K & d_E(e_1, e_2) \\ d_E(e_2, e_1) & 1 & K & d_E(e_2, e_1) \\ M & M & M & M \\ d_E(e_n, e_1) & d_E(e_n, e_2) & K & 1 \end{bmatrix}$$

If $d_E(e_i, e_j) = d_{ij}$, we can write matrix

$$d_E = \begin{bmatrix} 1 & d_{11} & K & d_{1n} \\ d_{21} & 1 & K & d_{2n} \\ M & M & M & M \\ d_{n1} & d_{n2} & K & 1 \end{bmatrix}$$

According to Saaty Rating Scale, for d_{13} means that how much important the parameter e_1 by parameter e_3. For example, if e_1 is very much more important by e_3, then we can write $d_{13} = 7$. While the transpose of d_{13}, so, we can enter the reciprocal value as $d_{13} = \frac{1}{7}$.

Table 1: The Saaty Rating Scale.

Intensity important	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Somewhat more important	Experience and judgement slightly favour one activity over another
5	Much more important	Experience and judgement strongly favour one activity over another
7	Very much more important	An activity is favoured very strongly over another
9	Absolutely more important	The evidence favouring one activity over another is of the highest possible validity
2,4,6,8	Intermediate values	When compromise is needed

Definition 4: Let f be a neutrosophic soft set and d_e be a relative parameter matrix of f. Then, score of parameters e_i, represented by c_i and is calculated as follows:

$$c_i = \sum_{j=1}^{n} d_{ij}$$

Definition 5: Normalized relative parameter matrix (nd_E) of relative parameter matrix d_E, represented by $\hat{d}$, is defined as follows:

$$nd_E = \begin{bmatrix} \dfrac{1}{c_1} & \dfrac{d_{12}}{c_1} & \wedge & \dfrac{d_{1n}}{c_1} \\ \dfrac{d_{21}}{c_2} & \dfrac{1}{c_2} & \wedge & \dfrac{d_{2n}}{c_2} \\ M & M & O & M \\ \dfrac{d_{n1}}{c_n} & \dfrac{d_{n2}}{c_n} & \wedge & \dfrac{1}{c_n} \end{bmatrix}$$

If $\frac{d_{ij}}{c_i} = \hat{d}_{ij}$, we can write matrix nd_E as

$$\hat{d} = \begin{bmatrix} \widehat{d_{11}} & \widehat{d_{12}} & \wedge & \widehat{d_{1n}} \\ \widehat{d_{21}} & \widehat{d_{22}} & \wedge & \widehat{d_{2n}} \\ M & M & O & M \\ \widehat{d_{n1}} & \widehat{d_{n2}} & \wedge & \widehat{d_{mn}} \end{bmatrix}$$

Definition 6: Let f be a neutrosophic soft set and $\hat{d}$ be a normalised parameter matrix of f. Then, weight of parameter $e_j \in E$, represented by $w(e_j)$ and is formulated as follows:

$$w(e_j) = \frac{1}{|E|} \sum_{i=1}^{n} d_{ij}$$

Definition 7: Let E be a parameter set and f be a neutrosophic soft set over Y. Then, $\forall e \in E$, comparison matrices of f, represented by $Y_{f(e)}$ is defined as follows:

$$Y_{f(e)} = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1m} \\ y_{21} & y_{22} & \cdots & y_{2m} \\ \vdots & \cdots & . & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mm} \end{bmatrix}$$

where

$$y_{ij} = \frac{\Delta T_e(y_{ij}) + \Delta I_e(y_{ij}) + \Delta F_e(y_{ij}) + 1}{2}$$

such that

$$\Delta T_e(y_{ij}) = T(e)(y_i) - T(e)(y_j)$$
$$\Delta I_e(y_{ij}) = I(e)(y_j) - I(e)(y_i)$$
$$\Delta F_e(y_{ij}) = F(e)(y_j) - F(e)(y_i)$$

Definition 8: Let $Y_{f(e)}$ be compare matrix for $e \in E$. Then, weight of $Y_j \in Y$ related to parameter $e \in E$, represented by $W_{f(e)}(y_j)$ is defined as follows:

$$W_{f(e)}(y_j) = \frac{1}{|Y|} \sum_{i-1}^{m} y_{ij}$$

Definition 9: Let E be a set of parameters, Y be an initial universe and $w(e)$ and $W_{f(e)}(y_j)$ be weight of parameter e and membership degree of y_j respectively which related to $e_j \in E$. Then, decision set, represented by D_E, is defined by the set of ordered pairs

$$D_E = \left\{ \left(y_j, F(y_j) \right) : y_j \in Y \right\}$$

where

$$F(y_j) = \frac{1}{|y|} \sum_{j=1}^{n} W_{ej} x W_{f(e)}(y_j)$$

3   Methodology

Let $Y = \{y_1, y_2, \dots, y_m\}$ be alternatives set, $E = \{e_1, e_2, \dots, e_n\}$ be a set of the parameters. Parameters are the attributes, characteristics, features or properties of objects in Y.

Step 1: Data Collection

Data from questionnaires to three students in UiTM Kelantan Branch were collected to obtain the value of membership for each element $y \in Y$ to the set of E as Table 2. Notice that y_1 is Grab food and y_2 is Food Panda. The collected data were converted into neutrosophic number according to Aydin et al. (2018) as in Table 3.

Table 2: Data collection converted into number of linguistic variables

Parameter	Alternatives	Student1	Student2	Student3
Delivery cost (E_1)	y_1	(0.70, 0.30, 0.30)	(0.55, 0.40, 0.45)	(0.55, 0.40, 0.45)
	y_2	(0.75, 0.25, 0.25)	(0.70, 0.30, 0.30)	(0.65, 0.30, 0.35)
Delivery speed (E_2)	y_1	(0.75, 0.25, 0.25)	(0.85, 0.20, 0.15)	(0.60, 0.35, 0.40)
	y_2	(0.80, 0.25, 0.20)	(0.60, 0.35, 0.40)	(0.60, 0.35, 0.40)
Convenience of payment (E_3)	y_1	(0.75, 0.25, 0.25)	(0.50, 0.50, 0.50)	(0.60, 0.35, 0.40)
	y_2	(0.85, 0.20, 0.15)	(0.55, 0.40, 0.45)	(0.55, 0.40, 0.45)
Web design (E_4)	y_1	(0.70, 0.30, 0.30)	(0.50, 0.50, 0.50)	(0.55, 0.40, 0.45)
	y_2	(0.85, 0.20, 0.15)	(0.60, 0.35, 0.40)	(0.55, 0.40, 0.45)
Marketing techniques (E_5)	y_1	(0.70, 0.30, 0.30)	(0.65, 0.30, 0.35)	(0.50, 0.50, 0.50)
	y_2	(0.90, 0.10, 0.10)	(0.80, 0.25, 0.20)	(0.60, 0.35, 0.40)
Order fulfillment (E_6)	y_1	(0.80, 0.25, 0.20)	(0.50, 0.50, 0.50)	(0.60, 0.35, 0.40)
	y_2	(0.85, 0.20, 0.15)	(0.50, 0.50, 0.50)	(0.65, 0.30, 0.35)

Table 3: Linguistic Variable Based on Neutrosophic Values

Linguistic term	Neutrosophic set
Extremely Highly Preferred	<0.90, 0.10, 0.10>
Extremely Preferred	<0.85, 0.20, 0.15>
Very strongly to Extremely Preferred	<0.85, 0.25, 0.20>
Very Strongly Preferred	<0.75, 0.20, 0.20>
Strongly Preferred	<0.70, 0.30, 0.30>
Moderately Highly to Strongly Preferred	<0.65, 0.30, 0.35>
Moderately Highly Preferred	<0.60, 0.35, 0.40>
Equally to Moderately Preferred	<0.55, 0.40, 0.45>
Equally Preferred	<0.50, 0.50, 0.50>

Step 2: Input the Neutrosophic Soft Set

The NSS were calculated by using the average value of the alternatives with respect to the parameter for each expert. The average is calculated by using equation (1) for each parameter as follows:

$$x_{ij} = \frac{1}{K}\left(x_{ij}^1 + x_{ij}^2 + ... + x_{ij}^K \right) \tag{1}$$

Thus, delivery cost (E_1) for y_1 were:

$$T_{f(e)} = \frac{0.7 + 0.55 + 0.55}{3} = 0.60$$

$$I_{f(e)} = \frac{0.30 + 0.40 + 0.40}{3} = 0.37$$

$$F_{f(e)} = \frac{0.30 + 0.45 + 0.45}{3} = 0.40$$

Other averages of E_2, E_3, E_4, E_5 and E_6 were calculated the same as above. Hence, the average value of alternative with respect to parameter is shown in Table 4.

Table 4: Average Value of Alternatives with Respect to Parameter

Parameter	Alternatives	Average
Delivery cost (E_1)	y_1	(0.60, 0.37, 0.40)
	y_2	(0.70, 0.28, 0.30)
Delivery speed (E_2)	y_1	(0.73, 0.27, 0.27)
	y_2	(0.67, 0.32, 0.33)
Convenience of payment (E_3)	y_1	(0.62, 0.37, 0.38)
	y_2	(0.65, 0.33, 0.35)
Web design (E_4)	y_1	(0.58, 0.40, 0.42)
	y_2	(0.67, 0.32, 0.33)
Marketing techniques (E_5)	y_1	(0.62, 0.37, 0.38)
	y_2	(0.77, 0.23, 0.23)
Order fulfillment (E_6)	y_1	(0.63, 0.37, 0.37)
	y_2	(0.67, 0.33, 0.33)

Therefore, the NSS of Table 4 can be written as follows:

$$f(Delivery\ cost) = \{< y_1, 0.60, 0.37, 0.40 >, < y_2, 0.70, 0.28, 0.30 >\}$$
$$f(Delivery\ speed) = \{< y_1, 0.73, 0.27, 0.27 >, < y_2, 0.67, 0.32, 0.33 >\}$$
$$f(Convenience\ of\ payment) = \{< y_1, 0.62, 0.37, 0.38 >, < y_2, 0.65, 0.33, 0.35 >\}$$
$$f(Web\ design) = \{< y_1, 0.58, 0.40, 0.42 >, < y_2, 0.67, 0.32, 0.33 >\}$$
$$f(Marketing\ techniques) = \{< y_1, 0.62, 0.37, 0.38 >, < y_2, 0.77, 0.23, 0.23 >\}$$
$$f(Order\ fulfillment) = \{< y_1, 0.63, 0.37, 0.37 >, < y_2, 0.67, 0.33, 0.33 >\}$$

Step 3: Construct the normalised parameter matrix, $\hat{d}$

In this step, relative parameter matrix denoted as d_E is obtained as follows:

$$d_E = \begin{bmatrix} 1 & 9 & 7 & 8 & 3 & 6 \\ \frac{1}{9} & 1 & 6 & \frac{1}{5} & 5 & \frac{1}{5} \\ \frac{1}{7} & \frac{1}{6} & 1 & \frac{1}{6} & 5 & 5 \\ \frac{1}{8} & 5 & 6 & 1 & \frac{1}{3} & \frac{1}{5} \\ \frac{1}{3} & \frac{1}{5} & \frac{1}{5} & 3 & 1 & 5 \\ \frac{1}{6} & 5 & \frac{1}{5} & 5 & \frac{1}{5} & 1 \end{bmatrix}$$

Then, the score of each parameter, E_i is calculated as follows by equation (2):

$$E_i = \sum_{j=1}^{n} d_{ij} \tag{2}$$

Hence,

$$E_1 = 1 + 9 + 7 + 8 + 3 + 6 = 34.00$$
$$.$$
$$.$$
$$.$$
$$E_6 = \frac{1}{6} + 5 + \frac{1}{5} + 5 + \frac{1}{5} + 1 = 11.57$$

So, $E_1 = 34.00$, $E_2 = 12.51$, $E_3 = 11.48$, $E_4 = 12.66$, $E_5 = 9.73$, $E_6 = 11.57$.

Thus, normalised parameter matrix was constructed as follows by equation (3):

$$nd_E = \begin{bmatrix} \dfrac{1}{E_1} & \dfrac{d_{12}}{E_1} & \wedge & \dfrac{d_{1n}}{E_1} \\ \dfrac{d_{21}}{E_2} & \dfrac{1}{E_2} & \wedge & \dfrac{d_{2n}}{E_2} \\ M & M & O & M \\ \dfrac{d_{n1}}{E_n} & \dfrac{d_{n2}}{E_n} & \wedge & \dfrac{1}{E_n} \end{bmatrix} \tag{3}$$

Hence, the normalised parameter matrix shows as:

$$\hat{d} = \begin{bmatrix} 0.03 & 0.26 & 0.21 & 0.24 & 0.09 & 0.18 \\ 0.01 & 0.08 & 0.48 & 0.02 & 0.40 & 0.02 \\ 0.01 & 0.01 & 0.09 & 0.01 & 0.44 & 0.44 \\ 0.01 & 0.39 & 0.47 & 0.08 & 0.03 & 0.02 \\ 0.03 & 0.02 & 0.02 & 0.31 & 0.10 & 0.51 \\ 0.01 & 0.43 & 0.02 & 0.43 & 0.02 & 0.09 \end{bmatrix}$$

Step 4: Compute the weight of each parameter, $w(E_j)$

The weight of each parameter is calculated using equation (4) as:

$$w_{E_j} = \frac{1}{|E|} \sum_{i=1}^{n} d_{ij} \tag{4}$$

$$w_{E1} = \frac{0.03 + 0.01 + 0.01 + 0.01 + 0.03 + 0.01}{|6|} = 0.018$$

$$.$$
$$.$$

$$w_{E6} = \frac{0.18 + 0.02 + 0.44 + 0.02 + 0.51 + 0.09}{|6|} = 0.207$$

so, the weight parameter is listed as:

$w_{(E_1)} = 0.018, w_{(E_2)} = 0.201, w_{(E_3)} = 0.214, w_{(E_4)} = 0.181, w_{(E_5)} = 0.178, w_{(E_6)} = 0.207$

Step 5: Construct the compare matrix for each parameter.

For each parameter, compared matrices were constructed as follows by equation (5):

$$y_{ij} = \frac{\Delta_{T_e}(y_{ij}) + \Delta_{I_e}(y_{ij}) + \Delta_{F_e}(y_{ij}) + 1}{2} \tag{5}$$

Thus, for delivery cost, since f (delivery cost) = $\{< y_1, 0.60, 0.37, 0.40 >, < y_2, 0.70, 0.28, 0.30 >\}$, then

$$\Delta_T(y_{12}) = 0.60 - 0.70 = -0.10$$
$$\Delta_I(y_{12}) = 0.28 - 0.37 = -0.09$$
$$\Delta_F(y_{12}) = 0.30 - 0.40 = -0.10$$

So, $$y_{12} = \frac{(-0.10) + (-0.09) + (-0.10) + 1}{2} = 0.358$$

Hence, comparison matrices for each parameter were constructed as followed:

$$Y_{f(Delivery\ cost)} = \begin{bmatrix} 0.5 & 0.358 \\ 0.641 & 0.5 \end{bmatrix} \qquad Y_{f(Delivery\ speed)} = \begin{bmatrix} 0.5 & 0.592 \\ 0.408 & 0.5 \end{bmatrix}$$

$$Y_{f\binom{Convenience\ of}{payment}} = \begin{bmatrix} 0.5 & 0.450 \\ 0.550 & 0.5 \end{bmatrix} \qquad Y_{f(Web\ design)} = \begin{bmatrix} 0.5 & 0.375 \\ 0.625 & 0.5 \end{bmatrix}$$

$$Y_{f(Marketing\ technique)} = \begin{bmatrix} 0.5 & 0.283 \\ 0.712 & 0.5 \end{bmatrix} \qquad Y_{f(Order\ fulfillment)} = \begin{bmatrix} 0.5 & 0.450 \\ 0.550 & 0.5 \end{bmatrix}$$

Step 6: Compute membership degree for all $y_j \in Y, W_{f(e)}(y_j)$.

For all $y_j \in Y$ and $e \in E$, the membership degree is computed using equation (6) thus return,

$$W_{fe}(y_j) = \frac{1}{|Y|} \sum_{i=1}^{m} y_{ij} \tag{6}$$

$W_{f(E_1)}(y_1) = 0.57$, $W_{f(E_1)}(y_2) = 0.43$, $W_{f(E_2)}(y_1) = 0.45, W_{f(E_2)}(y_2) = 0.55$, $W_{f(E_3)}(y_1) = 0.53$, $W_{f(E_3)}(y_2) = 0.48$, $W_{f(E_4)}(y_1) = 0.56, W_{f(E_4)}(y_2) = 0.44$, $W_{f(E_5)}(y_1) = 0.61, W_{f(E_5)}(y_2) = 0.39, W_{f(E_6)}(y_1) = 0.53$ and $W_{f(E_6)}(y_2) = 0.48$.

Step 7: Construct decision set, D_E.

By using step 4 and step 6, D_E is constructed as follows by equation (7):
$$D_E = (y_j, F(y_j)) : y_j \in Y$$

where

$$F(y_j) = \frac{1}{|Y|} \sum_{j=1}^{n} w(e_j) \times W_{f(e)(y_j)} \tag{7}$$

Thus, the decision set, D_E for each alternative are:

$$D_E(y_1) = \frac{1}{|6|} \times \begin{Bmatrix} (0.57 \times 0.018) + (0.45 \times 0.201) + (0.53 \times 0.214) + \\ (0.56 \times 0.181) + (0.61 \times 0.178) + (0.53 \times 0.207) \end{Bmatrix} = 0.089$$

and

$$D_E(y_2) = \frac{1}{|6|} \times \begin{Bmatrix} (0.48 \times 0.018) + (0.55 \times 0.201) + (0.48 \times 0.214) + \\ (0.44 \times 0.181) + (0.39 \times 0.178) + (0.48 \times 0.207) \end{Bmatrix} = 0.078$$

Hence, the decision set, D_E is rewrite as:

$$D_E = \{(y_1, 0.089), (y_2, 0.078)\}$$

Step 8: Obtain the optimal decision.

Based on the decision, the membership degree of y_1 (Grab Food) is greater than y_2 (Food Panda). Therefore, Grab Food is identified as the optimal choice in this decision-making process.

4   Results and Discussion

After constructing the NSS, the relative parameter matrix was developed, and the scores for each parameter were calculated. Using these scores and the relative parameter values, the normalized parameter matrix was then computed. Table 5 presents the parameter weights obtained in Step 4 along with their corresponding rankings.

Table 5: Weight of Parameter.

Parameter	Weight	Rank
Delivery cost (E1)	0.018	6
Delivery speed (E2)	0.201	3
Convenience of payment (E3)	0.214	1

Web design (E4)	0.181	4
Marketing technique (E5)	0.178	5
Order fulfillment (E6)	0.207	2

As shown in Table 5, convenience of payment holds the highest weight at 0.214, indicating it is the most influential parameter. This is followed by order fulfillment and delivery speed, which are also considered highly significant. Web design and marketing techniques rank next in importance. In contrast, delivery cost, with a weight of 0.018, is identified as the least important parameter among those evaluated. The optimal decision set derived from the alternatives, as determined in Step 8, is displayed in Table 6.

Table 6: Value of Decision Set.

y_1	Grab Food	0.089
y_2	Food Panda	0.078

Table 6 indicates that Grab Food achieved the highest decision values compared to Food Panda. Therefore, Grab Food is identified as the optimal alternative and the most preferred OFD service among students at the UiTM Kelantan Branch. The rapid advancement of internet and wireless technologies, coupled with improvements in telecommunication infrastructure and increased consumer purchasing power, has contributed to the rise of new business models such as OFD services. This growth is further driven by the lifestyle changes of modern consumers, many of whom prefer the convenience of ordering food online due to time constraints and busy schedules.

5   Conclusion and Recommendations

In this study, the NSS method was applied to determine the most preferred OFD company. The analysis identified Grab Food as the optimal choice. These findings can assist OFD providers in enhancing their services by aligning them more closely with customer preferences and demands. The most influential parameters identified were convenience of payment, order fulfillment, and delivery speed. Therefore, it is essential for OFD companies to focus on improving these aspects to better meet consumer expectations.

For future research, it is recommended to include a wider range of alternatives and parameters to provide a more comprehensive analysis. Additionally, researchers may explore other decision-making methods, such as the Fuzzy Analytic Hierarchy Process (FAHP) and the Weighted Aggregated Sum Product Assessment (WASPAS), for selecting OFD services. Comparing the results obtained through NSS with those derived from other methods could also help validate the accuracy and reliability of the selected OFD provider.

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Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

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