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RANKING ONLINE SHOPPING APPLICATION USING FUZZY TOPSIS APPROACH

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Abstract:

Nowadays, there are many online shopping applications used by modern society. However, the growth of online shopping applications has left users with a challenge of discerning the most reliable platform that meets with personal preferences. The wide range of alternatives complicates the decision-making process, requiring the need to determine the best alternative. Therefore, this paper aims to identify the best online shopping applications among students at UiTM Perlis by using Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach. During the analysis, primary data is collected through an online questionnaire distributed to UiTM Perlis students. In this study, it considers ZALORA, Shopee, TikTok Shop, SHEIN, and Lazada as alternatives. The criteria for evaluation are system quality, information quality, and service quality. The result of fuzzy TOPSIS highlights that Shopee as the top-ranked online shopping application, thus directly being acknowledged as the best among the alternatives. TikTok Shop comes in second, followed by ZALORA, Lazada and SHEIN. This study gives significant knowledge into the preferences of UiTM Perlis students, offering a practical application of the Fuzzy TOPSIS approach of making decisions in the realm of online shopping application and hence, contributes to the ongoing discussion over dependable approach for selecting the best online shopping apps particularly in the context of user satisfaction.

Keyword:
Fuzzy TOPSIS, Online Shopping Application, Ranking, Students

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Introduction

Nowadays, most individuals prefer to buy things online. In this day, e-commerce has grown in popularity as a means of acquiring necessities as everything is readily available to us and can be done with just one click from any location at any time. (Mohamad Shariff & Hamid, 2021). The popularity of e-commerce is growing due to the convenient, affordable, and accessible shopping experience. Online purchasing is becoming more popular because it's accessible, economical, and convenient. Consumers can shop from the comfort of their homes with online shopping because they are unable to attend physical stores (Abu Hasan et al., 2023).

People tend to be caught up with hectic daily schedules, so online shopping is a wise choice which does not require them to go to physical stores. They can explore items via different shopping applications when they purchase online. These applications are designed to make it more convenient for them so that they can make a better decision to purchase items after taking a few into factors consideration including functionality, interface and pricing information (Lin & Sun, 2009).

The best application can lead to user satisfaction which means choosing the right application is one of the vital considerations when making an online purchase. There are many sets of criteria that can be used to evaluate the success of online shopping apps. DeLone and McLean (2004) identified six variables for assessing the effectiveness of online shopping applications. These variables, widely recognized in information system research, encompass system quality, information quality, service quality, usage, user satisfaction, and net benefits.

Presently, the modern world uses a lot of internets purchasing applications. Thus, it is hard for users to choose application that can satisfy accordingly to their needs. One of the common problems faced by customers before shopping online is choosing the most reliable shopping applications to shop online. This is because users have their own preferred online shopping applications that they browse every time they want to purchase products due to a practical reason for being their choice. Users are faced with different features, interface and service offered by the various applications making it difficult to make decisions. Therefore, this study was conducted to find the best online shopping applications based on different criteria using Fuzzy TOPSIS method.

Literature Review

There are a range of fuzzy multi-criteria decision-making (FMCDM) approaches that are widely implemented for various real-life decision-making problems by many researchers. Among numerous FMCDM approaches, the Technique for Order Preference by Similarity to

Ideal Solution (TOPSIS) had been applied in this study. In accordance with Hwang and Yoon (1981), fuzzy TOPSIS was initially proposed by Hwang and Yoon. In general, TOPSIS is created based on the principle that the preferred alternative should be the closest to the fuzzy positive ideal solution (FPIS) and the furthest away from the fuzzy negative-ideal solution (FNIS). According to NĂdĂban et al. (2016), TOPSIS in a fuzzy environment is introduced to deal with human judgement and uncertainty in making decision. In this context, decision makers need to make decision without knowing any information related to the outcomes. Decision makers need to rate, select or rank these alternatives against the specified criteria based on the linguistics variables. Then, it will be converted into fuzzy numbers. With that, the aggregate fuzzy numbers are computed.

A few years back, some fuzzy TOPSIS methods were developed in different applied field. For example, Mahmud et al. (2022) conducted a study to rank the factors of committing crime involving foreign workers using fuzzy TOPSIS. The alternative is the factors of committing crimes by foreign workers, which are lack of facilities, poverty, wage discrimination, fraud by employment agents, alcohol and drug abuse, and poor education level while the criteria chosen are ex-criminal, desperate individual, legal immigrant and illegal immigrant. Results shows that the highest ranking for the factors of committing crime by foreign workers is wage discrimination and the minor contributing is property. In addition, Muhammat Pazil et al. (2018) proposed fuzzy TOPSIS approach to select and rank the significant factor which influence the selection of university between IPTA and IPTS. There are four alternatives listed which affiliation, course offered, cost of education and reputation. The result shows that the major factor is affiliation followed by reputation, cost of education and course offered. This proves that Fuzzy TOPSIS is able in aiding the selection of the best option to achieve the best result.

Several previous studies had used fuzzy TOPSIS in order to rank online shopping application. According to Alptekin et al. (2015), fuzzy TOPSIS was employed in analysing five online bookstore sites quality focusing on Turkey among 21 regulars. In the study, the researchers concentrate on the fifteen sub-criteria under four main criteria which are service quality, system quality, information quality and vendor-specific quality. Hence, they developed the model consisting of five alternatives and fifteen sub-criteria under the four main criteria. With this approach, they are able to rank the bookstores sites with alternative number four which is idefix.com as the best online bookstore. Furthermore, Kang et al. (2016) proposed fuzzy TOPSIS approach to evaluate e-commerce websites. There are six alternatives that were selected by the researchers. Besides, four elements of criteria as well as 22 sub-criteria were implemented in this study to evaluate the website features. These include efficiency, availability, privacy and fulfilment. By computing all the steps in fuzzy TOPSIS approach, five websites were evaluated.

In order to rank online shopping website, Suhada et al. (2021) applied fuzzy TOPSIS method. There are four alternatives of online shopping websites chosen from the largest shopping websites in Malaysia which are Lazada, Shopee, 11street and Lelong.my. These alternatives were than evaluated based on service quality, specific holdup fees and issues associated with technology adoption. As a result, Lazada was deemed determined the best online shopping website among UiTM Kelantan students followed by Shopee, 11Street and Lelong.my.

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There are six success variables of the DeLone and McLean Information Systems Success Model that can be implemented to measure the success of online shopping applications include system quality, information quality, service quality, usage, user satisfaction and net benefits. DeLone and McLean (2004). However, the first three variables which are system quality, information quality and service quality are said to be influenced to the user satisfaction. Meanwhile, for other three are the internal factor that only related to the organization or company. System quality measures how the quality of information system processing as a whole, which incorporates software and its data components (Gorla et al., 2010). In the context of online shopping applications, system reliability, response time, user-friendliness and easy to access are the example of attributes valued by users.

Furthermore, information quality is another criterion that should be selected. This is because it refers to the quality of information system outputs which is the content of sites. For instance, relevancy, accuracy, completeness and comprehensible information are the traits of information quality. These attributes include user's online buying habits. A user will abandon an application or website if it is not able to effectively display its main business contents or have low rating of the customer service. This will only make it difficult for the user to obtain the information they seek. As a result, analysing online shopping applications using this criterion is required.

In addition, service quality which is commonly defined as the output of the service delivery system related to user satisfaction based on variety elements(Vu, 2021). It stated that there are five superior elements of service quality which are tangibles, reliability, responsiveness, assurance and empathy. However, in the case of online shopping applications, service quality is characterized by the fact that they are intangible, simultaneous, human interaction and perishability (Cox & Dale, 2001).

There are several other approaches associated with decision making problems while evaluating shopping applications. For example, Aydin and Kahraman (2012) used fuzzy VIKOR or also known as multi-criteria optimization and compromise solution and fuzzy Analytic Hierarchy Process (AHP) to rank online shopping website in Turkey. The result gained via these two different approaches are being compared in the study. The researchers mentioned that measuring the quality of an online shopping website can be viewed as MCDM problems. There are three alternatives, five criteria and 20 sub-criteria were selected in the study. The considered criteria in the study include the ease of use, product, security, customer service and fulfilment. At the end of the study, it stated that both approaches show the same ranking result.

Another studies by Panjaitan and Aprilia (2020) implemented Elimination Et Choix Traduisant la Reality (ELECTRE) approach in selecting of online stores in Indonesia. This method can be used to rank and evaluate the alternatives based on the strengths and weaknesses using a pairwise comparisons on the same criteria. The data is collected among the students at University of Medan City to select the best online store between Tokopedia, Lazada, Blibli, Shopee and Bukalapak. In order to evaluate these websites, there are six criteria which are delivery cost, shipping time, quality of the product, price and completeness of the products. After implementing the method, Tokopedia was selected as the best online store in Indonesia among the decision makers at the University of Medan City.

Besides,Muhamad et al. (2022) discovered that the evaluation of e-commerce can be computed using fuzzy AHP approach. The researchers aimed to identify the criteria and its sub-criteria in selecting the best e-commerce website and rank the e-commerce website in Malaysia. Shopee,

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Lazada and PGMall are the three website that have been chosen by the researcher to be analysed. Meanwhile, the selected criteria to evaluate the website are information quality, service quality and system qualit. In the study, Shopee is the top e-commerce followed by Lazada and PGMall.

Methodology

The study aimed to evaluate the usage of online shopping application by employing a structured questionnaire as the primary method of data collection that was distributed to 130 respondents, encompassing UiTM Perlis students with different faculties. The questionnaire consists of two sections. Section A cover online shopping preference while Section B requires respondents to rank the criteria and alternatives of online shopping applications based on each criteria using linguistic variables as listed in Table 1 and Table 2 (NĂdĂban et al., 2016). The alternatives are ZALORA, Shopee, TikTok Shop, SHEIN and Lazada. Meanwhile, the criteria are system quality, information quality and service quality (DeLone & McLean, 2004). Figure 1 shows all the criteria and alternatives in choosing online shopping application.

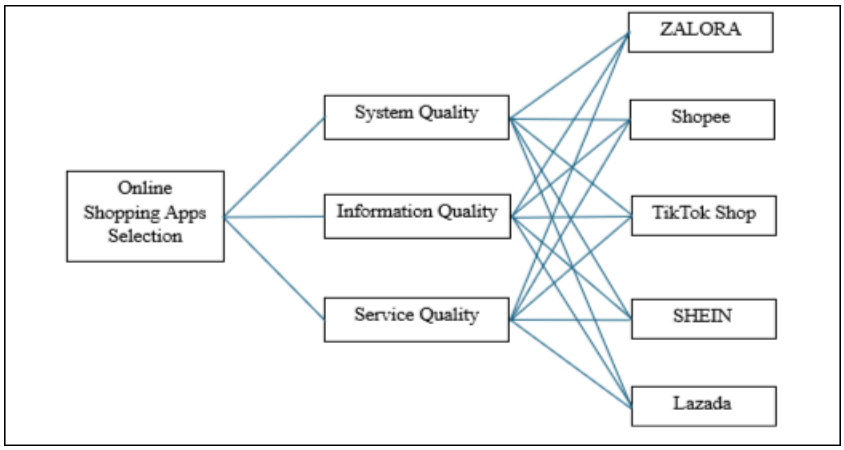

Figure 1: Hierarchy Structure for Choosing Online Shopping Apps

Table 1: Linguistic Variable for The Important of Criteria

Linguistic variables	Triangular Fuzzy Number
Not important at all	(0.00,0.10,0.30)
Slightly important	(0.10,0.30,0.50)
Moderately Important	(0.30,0.50,0.75)
Important	(0.50,0.75,0.90)
Very important	(0.75,0.90,1.00)

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Table 2: Linguistic Variable for The Alternatives Based on Criteria

Linguistic variables	Ratings value	Triangular Fuzzy Number
Very poor	1	(1,1,3)
Poor	2	(1,3,5)
Medium	3	(3,5,7)
Good	4	(7,9,10)
Very good	5	(9,10,10)

Steps in Fuzzy TOPSIS

Fuzzy Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) was applied in the decision-making process of this study. In accordance with Mahmud et al. (2018), there are five steps involved in this study.

Step 1: Group of decision makers are formed and the rating for the criteria and alternatives are assigned by the decision makers.

Assume that in this a group of decision makers of K respondents will be formed. The fuzzy rating of alternatives A_i denoted $x_{ij} = \left(a_{ij}, b_{ij}, c_{ij}\right)$ and the weight of criterion C_j is denoted $w_j = \left(w_{j1}, w_{j2}, w_{j3}\right)$. The fuzzy numbers for each criterion and alternatives were assigned. Then, the average fuzzy numbers for each alternative and the average fuzzy weight of each criterion were calculated. The average fuzzy numbers for the alternatives of i^{th} alternative with respect to j^{th} criterion is given as follows:

$$x_{ij} = \left(a_{ij}, b_{ij}, c_{ij}\right);\ i = 1, 2, ..., m \quad j = 1, 2, ..., n \tag{1}$$

$$w_j = \left(w_{j1}, w_{j2}, w_{j3}\right); j = 1, 2, ..., n \tag{2}$$

$$a_{ij} = \frac{1}{K}\sum_{k=1}^{K} a_{ij}^{k}, \quad b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ij}^{k}, \quad c_{ij} = \frac{1}{K}\sum_{k=1}^{K} c_{ij}^{k} \tag{3}$$

$$w_{j1} = \frac{1}{K}\sum_{k=1}^{K} w_{j1}^{k}, \quad w_{j2} = \frac{1}{K}\sum_{k=1}^{K} w_{j2}^{k}, \quad w_{j3} = \frac{1}{K}\sum_{k=1}^{K} w_{j3}^{k} \tag{4}$$

x_{ij} and w_j are the linguistic values that can be conveyed by the triangular fuzzy numbers as shown in Table 1 and Table 2 respectively.

Step 2: The normalized fuzzy decision matrix was constructed.
The normalized fuzzy decision matrix is $R = \left[\tilde{r}_{ij}\right]$, $i = 1, 2, ..., m$, $j = 1, 2, ..., n$

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^{+}}, \frac{b_{ij}}{c_j^{+}}, \frac{c_{ij}}{c_j^{+}}\right), \ c_j^{+} = \max_i \left\{c_{ij}\right\} \text{ (benefit criteria)} \tag{5}$$

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$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{c_{ij}}, \frac{a_j^-}{c_{ij}} \right), \; a_j^- = \min_i \left\{ a_{ij} \right\} \text{ (cost criteria)} \tag{6}$$

Step 3: The weighted normalized fuzzy decision matrix was constructed:
The weight normalized fuzzy decision matrix is $V = \left[\tilde{v}_{ij} \right], i = 1,2,....,m, \; j = 1,2,....,n$

$$\text{Where } \tilde{v}_{ij} = \tilde{r}_{ij} \times w_j \tag{7}$$

Step 4: The Fuzzy Positive Ideal Solution (FPIS A^+) and Fuzzy negative Ideal Solution (FNIS A^-) were determined as follows:

$$A^+ = \left(\tilde{v}_1^+, \tilde{v}_2^+, ..., \tilde{v}_n^+ \right), \quad \tilde{v}_j^+ = \max_i \left\{ v_{ij} \right\}, i = 1,2,3,....,m \;\; , j = 1,2,3,....., n \tag{8}$$

$$A^- = \left(\tilde{v}_1^-, \tilde{v}_2^-, ..., \tilde{v}_n^- \right), \quad \tilde{v}_j^- = \min_i \left\{ v_{ij} \right\}, i = 1,2,3....,n \;\; , j = 1,2,3,....., n \tag{9}$$

The distance for each alternative from FPIS and FNIS was calculated. The distance between two fuzzy triangular numbers is

$$d(a,b) = \sqrt{\frac{1}{3}\left[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2 \right]} \tag{10}$$

Then, the fuzzy distance of each alternative from fuzzy positive, d_x^+ and fuzzy negative ideals solution, d_x^- calculated as:

$$d_x^+ = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^+ \right) \tag{11}$$

$$d_x^+ = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^- \right) \tag{12}$$

Step 5: The closeness coefficient for each alternative was calculated and the alternatives were ranked based on the closeness coefficient.

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \tag{13}$$

Result and Discussions

The results were generated from the method of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) using the steps given in methodology. There are five steps in this method. The steps and results are expressed in Tables 3 until Table 9.

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Step 1: A group of decision-making committees of 130 respondents who are familiar with alternatives given are chosen among the students of UiTM Perlis. The alternatives A_i are chosen to rank, namely ZALORA, Shopee, TikTok Shop, SHEIN and Lazada. Besides, Main criteria C_j also are chosen to evaluate which are system quality, information quality and service quality. With that, five alternatives are identified as A_1, A_2, A_3, A_4 and A_5 respectively with three criteria as C_1, C_2 and C_3 respectively. The average fuzzy numbers for each alternative and the average fuzzy weight of each criterion were calculated using Equation (1) and Equation (2) are as table below:

Table 3: Average Fuzzy Numbers for Alternative

Alternatives	Criteria		
	C_1	C_2	C_3
A_1	(2.3692,3.6615,5.4769)	(2.6923,4.0000,5.7231)	(2.8615,4.1231,5.8000)
A_2	(7.3692,8.8462,9.4923)	(7.4769,8.9231,9.5154)	(6.9846,8.5692,9.3462)
A_3	(6.7846,8.2923,9.0769)	(6.1692,7.7692,8.7462)	(6.4154,7.9385,8.8385)
A_4	(2.1077,3.4538,5.3385)	(2.1538,3.6769,.5462)	(2.1538,3.5538,5.4000)
A_5	(2.5538,3.9385,5.7615)	(2.4000,3.5692,5.4154)	(2.6000,3.8231,5.6154)

Table 4: Average Fuzzy Weight for Criterion

Criteria	Fuzzy Weight	The Important of Criterion
C_1 (System Quality)	(0.5231,0.7219,0.8831)	1
C_2 (Information Quality)	(0.4677,0.6777,0.8550)	2
C_3 (Service Quality)	(0.5131,0.7027,0.8700)	3

Step 2: The normalized fuzzy decision matrix for benefit criteria and cost criteria.
The values for the normalized decision matrix of benefit criteria were calculated using Equation (5) while the value for the normalized decision matrix of cost criteria was computed using Equation (6). Table 5 show the results of the normalized fuzzy decision matrix.

Table 5: Normalized Fuzzy Decision Matrix

Alternatives	Criteria		
	C_1	C_2	C_3
A_1	(0.2496,0.3857,0.5770)	(0.2829,0.4204,0.6015)	(0.3062,0.4412,0.6206)
A_2	(0.7763,0.9319,1.0000)	(0.7858,0.9378,1.0000)	(0.7473,0.9169,1.0000)
A_3	(0.7147,0.8736,0.9562)	(0.6483,0.8165,0.9192)	(0.6864,0.8494,0.9457)
A_4	(0.2220,0.3639,0.5624)	(0.2264,0.3864,0.5829)	(0.2305,0.3802,0.5778)
A_5	(0.2690,0.4149,0.6070)	(0.2522,0.3751,0.5691)	(0.2782,0.4091,0.6008)

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Step 3: The weighted normalized fuzzy decision matrix
Equation (7) was used to generate the weighted normalized fuzzy decision matrix which is presented in Table 6 below.

Table 6: Weight Normalized Fuzzy Decision Matrix

Alternatives	Criteria		
	C_1	C_2	C_3
A_1	(0.1306,0.2785,0.5095)	(0.1323,0.2849,0.5142)	(0.1571,0.3100,0.5399)
A_2	(0.4061,0.6728,0.8831)	(0.3675,0.6355,0.8550)	(0.3834,0.6443,0.8700)
A_3	(0.3739,0.6308,0.8444)	(0.3032,0.5533,0.7859)	(0.3522,0.5969,0.8227)
A_4	(0.1161,0.2627,0.4966)	(0.1059,0.2619,0.4983)	(0.1182,0.2672,0.5027)
A_5	(0.1407,0.2995,0.5360)	(0.1180,0.2542,0.4866)	(0.1427,0.2874,0.5227)

Step 4: The fuzzy distance of each alternative from fuzzy positive, d_x^+ and fuzzy negative ideals solution, d_x^-.
Table 7 and Table 8 show the shows the distance between two fuzzy triangular numbers from each alternative to the FPIS and FNIS. The fuzzy distance of each alternative was computed by using Equation (10), (11) and (12) while FPIS and FNIS values based on Equation (8) and Equation (9).

Table 7: The Distance Between Two Fuzzy Triangular Numbers from Each Alternative to The FPIS

Alternatives	Criteria			Total d_x^+
	C_1	C_2	C_3	
A_1	0.3516	0.3132	0.3011	0.9659
A_2	0.0000	0.0000	0.0000	0.0000
A_3	0.0379	0.0732	0.0427	0.1528
A_4	0.3659	0.3343	0.3403	1.0405
A_5	0.3318	0.3383	0.3193	0.9894

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Table 8: The Distance Between Two Fuzzy Triangular Numbers from Each Alternative to the FNIS

Alternatives	Criteria			Total
	C_1	C_2	C_3	d_x^-
A_1	0.0144	0.0222	0.0397	0.0763
A_2	0.3659	0.3343	0.3403	1.0405
A_3	0.3280	0.2624	0.2977	0.8881
A_4	0.0000	0.0000	0.000	0.0000
A_5	0.0342	0.0107	0.0217	0.0666

Step 5: The closeness coefficient for each alternative.
Table 9 shows the closeness coefficient was calculated by using Equation (13). Based on Table 11, the ranking order of these five alternatives is Shopee (A_2), TikTok Shop (A_3) , ZALORA (A_1) Lazada (A_5) and SHEIN (A_4) respectively.

Table 9: The Closeness Coefficient for Five Alternatives

Alternatives	d_x^+	d_x^-	CC_i	Rank
A_1 (ZALORA)	0.9659	0.0763	0.0731	3
A_2 (Shopee)	0.0000	1.0405	1.0000	1
A_3 (TikTok Shop)	0.1528	0.8881	0.8532	2
A_4 (SHEIN)	1.0405	0.0000	0.0000	5
A_5 (Lazada)	0.9894	0.0666	0.0631	4

Conclusion

The objective of this study is to identify the best online shopping application among UiTM Perlis students, with an emphasis on Zalora, Shopee, TikTok Shop, SHEIN and Lazada using fuzzy TOPSIS. Shopee become the top-ranked online shopping applications with the greatest closeness coefficient value which is 1.000. Meanwhile. TikTok Shop follows closely behind, indicating the second rank, followed by Zalora, Lazada and SHEIN.

The most important criterion is system quality, pointing out decision makers' demand for a solid technical foundation. It reveals that UiTM Perlis students place a high value on the overall quality and performance of the application systems, which includes requirements such as responsiveness, reliability, and user-friendliness of the app interfaces. This has shown that system quality plays an important role in the decision-making process, signifying that students favour a solid technical foundation when selecting an online shopping application. information quality is determined as the second important criterion. While information quality is deemed important compared to system quality, it implies that decision makers value precise product

details and trustworthy information in their application choices. Lastly, decision makers recognise the need for an excellent optimal service experience but regard it to be considerably less important than technical and informational aspects. This result may pave the way for developers to make a more informed and targeted approach. This is because it can help them in enhancing specific features that fit with the preferred criteria. From the result, Shopee is clearly the top online buying website of these four online shopping websites. The Shopee shopping applications is user friendly, offer a wide range of product and ships quickly. Shopee frequently offer large discounts especially during big events. As a result, Shopee meets the system quality, information quality and service quality.

The findings of this study on ranking the best online shopping apps by applying fuzzy TOPSIS methodology offer helpful perspective on new possibilities for further research. For instance, it would be great to widen the scope of the study beyond the online shopping application assigned for this study. A broader selection of online shopping application is crucial since it will contribute to a more comprehensive understanding of customer preferences. Furthermore, to advance the current study's framework, other researchers could extend the evaluation for different criteria that also can potentially affect the decision-making process. This enhancement would be able to address a greater range of uncertainty and ambiguity of user needs. Besides, it is recommended that future research broadens the decision makers pools from different population as they would give distinct views of the criteria in evaluating online shopping apps. Additionally, it is also suggested that future research utilize other fuzzy Multi Criteria Decision Making (FMCDM) approaches such as fuzzy Analytic Hierarchy Process (AHP), fuzzy VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) and fuzzy Elimination Et Choix Traduisant la Realité (ELECTRE) to rank online shopping apps.

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