e-ISSN : 2600-8793

Available online at
https://jcrinn.com/
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Journal of Computing Research and Innovation 9(1) 2024

Journal of Computing Research and Innovation

The Ranking of Factors in Selecting the Online Shopping Platform in Malaysia based on Fuzzy Analytic Hierarchy Process

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ARTICLE INFO

Article history:
Received: 3 January 2024
Revised: 13 February 2024
Accepted: 14 February 2024
Online first: 1 March 2024
Published 1 March 2024

Keywords:
Analytic Hierarchy Process
E-commerce
Online Shopping Platform

DOI:
10.24191/jcrinn.v9i1.393

ABSTRACT

There is an increasing number of online shopping platforms nowadays. People sometimes may have difficulties in choosing an ideal online shopping platform to suit their wants and needs. This study aims to rank the factors that influence consumers in selecting an online shopping platform in Malaysia. The Fuzzy Analytic Hierarchy Process is employed in this study to accomplish its objectives by ranking four factors: user-friendliness, trustworthiness, price and promotion, and responsiveness. The decision-makers for this study include an executive marketer from a business company and a lecturer with marketing expertise from UiTM Arau, Perlis. The results highlight a clear trend, indicating that pricing and promotions are the most important factors, holding the highest normalized weight. Subsequent in significance are user-friendliness, trustworthiness, and responsiveness. This insight into the hierarchical significance of these factors contributes valuable perspectives for both academics and practitioner in the field of online shopping platforms.

1. INTRODUCTION

Since many decades ago, individuals engaged in business transactions primarily within physical stores, commonly known as traditional brick-and-mortar establishments. Sales transactions occurred within business premises such as retail stores, characterized by face-to-face interactions. However, with the ongoing evolution of technology and the expansion of services facilitated by connectivity, activities that were traditionally conducted in person are now transitioning to online platforms (Dias et al., 2020).

Online shopping is an alternative for individuals to buy anything without going out, especially during the COVID-19 pandemic, where people are prohibited from going out to avoid the potential of contracting with the virus. According to Amsari and Sari (2022), people had to change their lifestyle after restrictions

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https://doi.org/10.24191/jcrinn.v9i1

were forced upon them, and this includes their shopping behaviour, which they had to start selling and/or buying through online shopping platforms. Thus, there is an increasing number of people visiting online shopping platforms, such as Shopee, Lazada, Amazon, Zalora, Carousell, Mudah.my, eBay, Sephora, Lelong, PrestoMall and so on.

The increasing number of online shopping platforms in Malaysia has brought many choices for consumers. In this dynamic landscape, users often find themselves confronted with the challenge of selecting the most optimal platform. The decision-making process is further complicated by the diverse factors of these platforms, including user-friendliness, trustworthiness, pricing and promotions, and responsiveness. While some platforms excel in certain aspects, others may lack in different areas, creating a need to prioritize and understand the factors that influence users' preferences.

This study aimed to rank the contributing factors that lead consumers to select an online shopping platform in Malaysia. According to the literature review, there are four factors that are most dominant and influence for users in choosing the online shopping platform, which are user-friendliness (Kiew et al., 2021; Manwaluddin et al., 2018; Tseng et al., 2021), trustworthiness (Huang et al., 2021; Faqih, 2022), price and promotion (Sheehan et al., 2019; Bucko et al., 2018), and responsiveness (Busalim et al., 2021; Hewei & Youngsook, 2022). In order to fulfil the objective, method of Fuzzy Analytic Hierarchy Process (FAHP) is applied. By employing this methodology, the study ranks and evaluates the significance of user-friendly interfaces, trustworthiness of platforms, pricing and promotional strategies, and responsiveness to user needs. Understanding the nuanced preferences and priorities of users in selecting online shopping platforms will provide valuable insights for businesses, policymakers, and academics.

In Section 2, some preliminaries consist of definition and theory on the triangular fuzzy number, FAHP and Saaty's scale are provided. In Section 3, the methodology that involved in the study is presented. Next, result and some discussion illustrated in Section 4. Finally, the conclusion is drawn in Section 5.

2. PRELIMINARIES

This section provides definition and theory particularly on triangular fuzzy number, FAHP and Saaty's scale which are used in this study.

2.1 Triangular fuzzy number

A fuzzy number of $\tilde{A} = (l, m, u)$ is said to be a triangular fuzzy number (TFN) if its membership function is given by,

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{x-l}{m-l}, & l \le x \le m, \\ \dfrac{u-x}{u-m}, & m \le x \le u, \\ 0, & \text{otherwise.} \end{cases}$$

where l and u represent the lower and upper bounds of the fuzzy number $\tilde{A}$, respectively, and m is the median value (Zadeh, 1965). The standard form of the TFN is demonstrated in Fig. 1.

https://doi.org/10.24191/jcrinn.v9i1

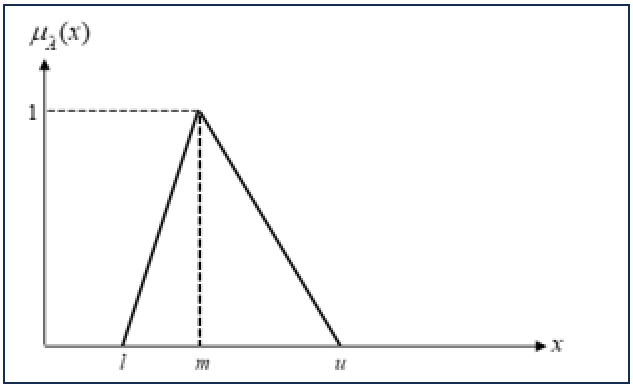

Fig. 1. Representation of a TFN (l, m, u)

2.2 Fuzzy Analytic Hierarchy Process (FAHP)

In the 1970s, Saaty introduced Analytic Hierarchy Process (AHP) as the main multi-criteria decision-making approach. A study by Díaz et al. (2022) stated Analytic Hierarchy Process is one of the common methods in solving selection problems and this method causes a hard decision to be decomposed by breaking it into various parts and allocate each problem's aspect with different weights and rankings. According to a previous study by Putra et al. (2018), AHP that has adapted with fuzzy logic theory, is called as a Fuzzy Analytic Hierarchy Process (FAHP). The only difference in FAHP method is that the AHP scale is placed into the fuzzy triangle scale to access priority.

Many problems related to decision-making use the FAHP method, for instance, the passenger aircraft type selection. Dožić et al. (2018) used the FAHP approach to choose an aircraft that could operate a designated set of routes while considering the passenger's interests and its own interests. Their study decided to use this method since there were uncertainties in making decisions and the aspect of human vagueness when reasoning for a multi-criteria problem. Market conditions and airlines' requirements are the significance in choosing aircraft type. A study by Li et al. (2017) also used the FAHP method to appraise in-flight service quality since one of the most important parts in the service process of air travel is the in-flight service, but they used a hybrid approach. Besides, another previous study by Putra et al. (2018) used the FAHP method to determine the quality of gemstones. Exceptional ability is required to select and assess the gemstones' quality so that it can be traded. When individuals possess minimal ability and knowledge and proceed to analyse the quality of gemstones, this can become an obstacle concerning the types of gemstones and consumers variation. According to Calabrese et al. (2019), FAHP was used to choose relevant sustainability issues. Environment and society are at risk of being affected by negative impacts generated by business activities from companies that failed to integrate sustainability into their process, long-term vision, and strategies.

2.3 Saaty's scale

In applying the FAHP method in this study, the used of the Saaty's scale is very important. The standard Saaty's scale (Saaty, 1980) that corresponds to the fuzzy triangular number and its linguistic term is given in Table 1.

https://doi.org/10.24191/jcrinn.v9i1

Table 1 Saaty's scale with the fuzzy triangular number and its linguistic term.

Classic Saaty's Scale	Fuzzy Triangular Number	Inverse of Fuzzy Triangular Number	Linguistic Term
1	(1,1,1)	$(1,1,1)$	Equally Important
3	(2,3,4)	$\left(\frac{1}{4},\frac{1}{3},\frac{1}{2}\right)$	Moderate Important
5	(4,5,6)	$\left(\frac{1}{6},\frac{1}{5},\frac{1}{4}\right)$	Strong Important
7	(6,7,8)	$\left(\frac{1}{8},\frac{1}{7},\frac{1}{6}\right)$	Very Strong Important
9	(9,9,9)	$\left(\frac{1}{9},\frac{1}{9},\frac{1}{9}\right)$	Extremely Strong Important
2	(1,2,3)	$\left(\frac{1}{3},\frac{1}{2},1\right)$	
4	(3,4,5)	$\left(\frac{1}{5},\frac{1}{4},\frac{1}{3}\right)$	Intermediate Values
6	(5,6,7)	$\left(\frac{1}{7},\frac{1}{6},\frac{1}{5}\right)$	
8	(7,8,9)	$\left(\frac{1}{7},\frac{1}{8},\frac{1}{9}\right)$	

3. METHODOLOGY

The methodology of this study involves a structured framework comprising ten essential steps.

Step 1: A questionnaire has been developed and answered by two chosen experts, which are a professional online marketer and a marketing lecturer from UiTM Perlis. The questionnaire consisted of three sections, which is in Section A involved the demographic issues such as genders, age, based company and working experiences. While in Section B and C involved the evaluation of the factors and sub-factors, respectively.

Step 2: The outcomes from the questionnaire are substituted into the pairwise comparison matrices based on the Saaty's scale as provided in the Table 1. The general form of pairwise comparison matrix is given as follows:

$$A=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (1)$$

where A is positive and symmetric matrix, since $a_{ji}=\frac{1}{a_{ij}}$ and $a_{ii}=1$ for every $i, j=1,2,3,\ldots,n$. In

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other words, if the essential preferences a_{ij} is located in the upper triangle of the matrix, then the reciprocal value $a_{ji} = \frac{1}{a_{ij}}$ must be at the lower triangle or vice versa (Bozanic, et al., 2013).

Step 3: Next, the consistency ratio (CR) of the experts' fuzzy triangular scale for the pairwise comparison matrix is calculated. The CR should be less than or equal to 10% (0.1), otherwise the pairwise comparison as in step 2, should be re-implemented. The CR is computed using the equation below:

$$\text{CR} = \frac{\text{Consistency index (CI)}}{\text{Random consistency index (RI)}} \tag{2}$$

where

$$\text{CI} = \frac{\lambda_{\max} - n}{n-1} \tag{3}$$

and $\lambda_{\max}$ is the largest eigenvalue of the comparison matrix and n is the number of samples. While, the random consistency index (*RI*) is based on the number of sample (Saaty, 1980), as given in Table 2.

Table 2. Random consistency index

Number of samples, *n*	1	2	3	4	5	6	7	8	9	10
Random Consistency Index, *RI*	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Step 4: Calculate the average of the expert preferences using the given formula:

$$Average\left(l_{ij}, m_{ij}, u_{ij}\right) = \frac{\sum_{k=1}^{k}\left(l_{nn}^{k}, m_{nn}^{k}, u_{nn}^{k}\right)}{k} \tag{4}$$

where k represents the number of experts. From the average value, the pairwise comparison is updated.

Step 5: Determine the fuzzy geometric mean, G_i for each factor based on the following equation:

$$\begin{aligned} G_i &= \left(\prod_{j=1}^{n} P_{ij}\right)^{\frac{1}{n}} \\ &= \left[(l_{i1}, m_{i1}, u_{i1}) \times (l_{i2}, m_{i2}, u_{i2}) \times \ldots \times (l_{in}, m_{in}, u_{in})\right]^{\frac{1}{n}} \\ &= \left(l_{G_i}, m_{G_i}, u_{G_i}\right) \end{aligned} \tag{5}$$

where $\prod_{j=1}^{n} P_{ij}$ is multiplied by each fuzzy value from the pair-wise comparison matrix. Subsequently,

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calculate the vector summation, V_{G_i} of the geometric mean for each factor using:

$$\begin{aligned} V_{G_i} &= \sum G_i \\ &= \left(\sum l_{G_i}, \sum m_{G_i}, \sum u_{G_i}\right) \end{aligned} \tag{6}$$

Step 6: Calculate the inverse of vector summation, $V_{G_i}^{-1}$.

$$V_{G_i}^{-1} = \left(\frac{1}{\sum l_{G_i}}, \frac{1}{\sum m_{G_i}}, \frac{1}{\sum u_{G_i}}\right) \tag{7}$$

Then, the $V_{G_i}^{-1}$ is arranged according to its order.

Step 7: Based on the new arrangement of $V_{G_i}^{-1}$, fuzzy weight of each factor W_i is determined using:

$$\begin{aligned} W_i &= G_i \times q \\ &= (l_{W_i}, m_{W_i}, u_{W_i}) \end{aligned} \tag{8}$$

where G_i is the fuzzy geometric mean for each factor and q is the new arrangement of $V_{G_i}^{-1}$.

Step 8: The fuzzy weight $(l_{W_i}, m_{W_i}, u_{W_i})$ is converted to non-fuzzy value, C_i or known as defuzzification process, which implemented using:

$$C_i = \frac{l_{W_i} + m_{W_i} + u_{W_i}}{3} \tag{9}$$

Step 9: For the non-fuzzy weight, the weight must be normalized using the following formula:

$$Z_i = \frac{C_i}{\sum_{i=1}^{n} C_i} \tag{10}$$

where Z_i is the final weight after normalization.

Step 10: Ranking and selection of decisions. This is based on normalized weight. The factors are ranked from the highest value to the lowest value. Hence, the highest value is the best factor.

4. RESULT AND DISCUSSION

Based on methodology presented in the previous section, the outcomes from the two experts are extracted to be in the form of pairwise comparison matrix as presented in Table 3. The consistency ratio (CR) also has been calculated.

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Table 3. Pairwise comparison matrix for both experts and their consistency ratios

Expert 1	Expert 2
$A=\begin{bmatrix} 1 & 2 & \frac{1}{3} & 1 \\ \frac{1}{2} & 1 & \frac{1}{3} & 1 \\ 3 & 3 & 1 & 4 \\ 1 & 1 & \frac{1}{4} & 1 \end{bmatrix}$	$A=\begin{bmatrix} 1 & 6 & \frac{1}{3} & 4 \\ \frac{1}{6} & 1 & \frac{1}{4} & 2 \\ 3 & 4 & 1 & 6 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{6} & 1 \end{bmatrix}$
$\lambda_{\max} = 4.0714$	$\lambda_{\max} = 4.2666$
$\text{CI} = \frac{4.0714-4}{4-1} = 0.0238$	$\text{CI} = \frac{4.2666-4}{4-1} = 0.0889$
Thus,	Thus,
$\text{CR} = \frac{0.0238}{0.9} = 0.0264$	$\text{CR} = \frac{0.0889}{0.9} = 0.0987$

Since both CR are less than 0.1, thus the comparisons made by the experts are considered acceptable and consistent.

Next, the average pairwise comparison matrix for all experts is calculated by setting up the triangular fuzzy number of comparison matrix from each expert (as in Table 4 and 5). Then, calculate the average using the Equation (4).

Table 4. Pairwise comparison matrix of Expert 1

Factor	User-Friendliness	Trustworthiness	Price & Promotion	Responsiveness
User-Friendliness	$(1,1,1)$	$(1,2,3)$	$\left(\frac{1}{4},\frac{1}{3},\frac{1}{2}\right)$	$(1,1,1)$
Trustworthiness	$\left(\frac{1}{3},\frac{1}{2},1\right)$	$(1,1,1)$	$\left(\frac{1}{4},\frac{1}{3},\frac{1}{2}\right)$	$(1,1,1)$
Price & Promotion	$(2,3,4)$	$(2,3,4)$	$(1,1,1)$	$(3,4,5)$
Responsiveness	$(1,1,1)$	$(1,1,1)$	$\left(\frac{1}{5},\frac{1}{4},\frac{1}{3}\right)$	$(1,1,1)$

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Table 5. Pairwise comparison matrix of Expert 2

Factor	User-Friendliness	Trustworthiness	Price & Promotion	Responsiveness
User-Friendliness	$(1,1,1)$	$(5,6,7)$	$\left(\frac{1}{4},\frac{1}{3},\frac{1}{2}\right)$	$(3,4,5)$
Trustworthiness	$\left(\frac{1}{7},\frac{1}{6},\frac{1}{5}\right)$	$(1,1,1)$	$\left(\frac{1}{5},\frac{1}{4},\frac{1}{3}\right)$	$(1,2,3)$
Price & Promotion	$(2,3,4)$	$(3,4,5)$	$(1,1,1)$	$(5,6,7)$
Responsiveness	$\left(\frac{1}{5},\frac{1}{4},\frac{1}{3}\right)$	$\left(\frac{1}{3},\frac{1}{2},1\right)$	$\left(\frac{1}{7},\frac{1}{6},\frac{1}{5}\right)$	$(1,1,1)$

Table 6. Average pairwise comparison matrix for all experts

Factor	User-Friendliness	Trustworthiness	Price & Promotion	Responsiveness
User-Friendliness	$(1,1,1)$	$(3,4,5)$	$\left(\frac{1}{4},\frac{1}{3},\frac{1}{2}\right)$	$\left(2,\frac{5}{2},3\right)$
Trustworthiness	$\left(\frac{1}{4},\frac{1}{3},\frac{3}{5}\right)$	$(1,1,1)$	$\left(\frac{2}{9},\frac{2}{7},\frac{2}{5}\right)$	$\left(1,\frac{3}{2},2\right)$
Price & Promotion	$(2,3,4)$	$\left(\frac{5}{2},\frac{7}{2},\frac{9}{2}\right)$	$(1,1,1)$	$(4,5,6)$
Responsiveness	$\left(\frac{3}{5},\frac{5}{8},\frac{2}{3}\right)$	$\left(\frac{2}{3},\frac{3}{4},1\right)$	$\left(\frac{1}{6},\frac{1}{5},\frac{1}{4}\right)$	$(1,1,1)$

Then, calculation of the fuzzy geometric mean of each factor was performed using the Equation (5). The following shows an example of geometric mean calculation for user-friendly factor.

$$G=\left(\left[1\times 3\times\frac{1}{4}\times 2\right]^{\frac{1}{4}},\left[1\times 4\times\frac{1}{3}\times\frac{5}{2}\right]^{\frac{1}{4}},\left[1\times 5\times\frac{1}{2}\times 3\right]^{\frac{1}{4}}\right) \tag{11}$$
$$=(1.1067,1.3512,1.6549)$$

Table 7 shows the fuzzy geometric mean for all factors.

Table 7. Fuzzy geometric mean for all factors.

	Fuzzy geometric mean		
User-Friendliness	1.1067	1.3512	1.6549
Trustworthiness	0.4811	0.6180	0.8409
Price & Promotion	2.1147	2.6918	3.2237
Responsiveness	0.5117	0.5590	0.6493
Vector Summation	4.214	5.220	6.369
Inverse Vector Summation	0.1570	0.1916	0.2373

https://doi.org/10.24191/jcrinn.v9i1

While, based on the geometric mean calculated in Equation (11), vector summation and inverse vector summation have been calculated using Equations (6) and (7), respectively.

$$\begin{aligned} V_G &= \sum G \\ &= \begin{pmatrix} [1.1067 + 0.4811 + 2.1147 + 0.5117], [1.3512 + 0.6180 + 2.6918 + 0.5590], \\ [1.6549 + 0.8409 + 3.2237 + 0.6493] \end{pmatrix} \\ &= (4.214, 5.220, 6.369) \end{aligned}$$

$$\begin{aligned} V_G^{-1} &= \left(\frac{1}{4.214}, \frac{1}{5.220}, \frac{1}{6.369} \right) \\ &= (0.2373, 0.1916, 0.157) \end{aligned}$$

Arrange in order

$$V_G^{-1} = (0.157, 0.1916, 0.2373)$$

Subsequently, Table 8 shows the fuzzy weight, non-fuzzy weight, and normalized weight that have been calculated using Equations (8-10). The example calculation for the user-friendliness factor is shown below.

$$\begin{aligned} W_{user-friendliness} &= \left([1.1067 \times 0.157], [1.3512 \times 0.1916], [1.6549 \times 0.2373] \right) \\ &= \left(0.1738, 0.2589, 0.3927 \right) \end{aligned}$$

$$\begin{aligned} C_{user-friendliness} &= \frac{0.1738 + 0.2589 + 0.3927}{3} \\ &= 0.2751 \end{aligned}$$

$$\begin{aligned} Z_{user-friendliness} &= \frac{0.2751}{1.0577} \\ &= 0.2601 \end{aligned}$$

Table 8. Fuzzy weight, non-fuzzy weight, and normalized weight of all factors

Factor	Fuzzy Weight, *W*	Non-Fuzzy Weight, *C*	Normalized Weight, *Z*	Rank
User-Friendliness	(0.1738, 0.2589, 0.3927)	0.2751	0.2601	2
Trustworthiness	(0.0755, 0.1184, 0.1995)	0.1312	0.1240	3
Price & Promotion	(0.3320, 0.5157, 0.7650)	0.5376	0.5083	1
Responsiveness	(0.0803, 0.1071, 0.1541)	0.1138	0.1076	4
	Sum	1.0577	1	

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Table 8 clearly shows that the four factors are ranked based on the normalized weight from the highest to the lowest value. The top-ranking factor is price and promotion, indicating a significant emphasis on favourable prices and special deals. In other words, people prefer platforms that not only offer fair prices but also provide discounts or promotions. Following closely is user-friendliness, reflecting Malaysians' preference for online shops that are easy to navigate, ensuring a hassle-free shopping experience.

Trustworthiness is the third crucial factor. Malaysians favour platforms that are reliable, secure, and transparent in their transactions, emphasizing the importance of building trust for businesses to retain customers. Lastly, responsiveness is the fourth factor, indicating that users desire platforms to promptly address their questions or issues. This involves having helpful customer support, swift order processing, and effective communication.

5. CONCLUSION

In conclusion, it is evident that the abundance of online shopping platforms, each with unique features, a diverse array of products, and varying services, often leaves users perplexed when attempting to select the most suitable option. This study aimed to address this dilemma by ranking the influencing factors behind users' choices when selecting an online shopping platform in Malaysia.

The assessment of the ranking procedure involved the distribution of questionnaires to experts in the field – an online marketing professional and a marketing lecturer at UiTM Arau, Perlis. The collected data was analysed using the Fuzzy AHP method, a combination of Fuzzy theory and the Analytic Hierarchy Process. This approach proved effective in achieving the study objectives by breaking down criteria, assigning fuzzy weights, and establishing rankings. Consequently, the study identifies the primary factor influencing users' choices as price and promotion, followed by user-friendliness, trustworthiness, and the lowest ranking is responsiveness.

Outside the academic realm, the results of this study can provide valuable insights for businesses. By offering fair prices, creating easy-to-use websites, and building trust with customers, online platforms can enhance the overall shopping experience. Policymakers and industry experts can also use these insights to support the growth of e-commerce in Malaysia.

Looking ahead, for future investigations, it is recommended to explore alternative methods such as Fuzzy TOPSIS, known for providing ideal solutions among similar options, or other Multi-Criteria Decision-Making (MCDM) methods. This diversification can enhance the robustness of the research outcomes by cross-validating results and ensuring a more comprehensive understanding of the factors influencing users in choosing online shopping platforms.

6. ACKNOWLEDGEMENT

The authors would like to acknowledge the support of Universiti Teknologi Mara (UiTM), Cawangan Perlis and Institute of Engineering Mathematics, UniMAP for providing the facilities support on this research. The authors would also like to express their gratitude to the anonymous referee for the constructive comments to improve this study.

https://doi.org/10.24191/jcrinn.v9i1

7. 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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