Evaluating Customer Trust towards Online SNSs sellers using Fuzzy AHP

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Abstract. Trust plays a vital role in social commerce due to the inadequacy of physical interaction and experience during the customer-seller transaction. Various studies were drawn in the literature targeting the investigation of the influence criteria related to trust using statistical analysis approach. However, little attention has been paid on the importance of the criteria in evaluating customer trust toward online sellers that used Social Network Sites (SNSs) as business platforms. In this study, the Fuzzy AHP (FAHP) method, an extension of the Analytical Hierarchy Process (AHP) was adopted to determine the importance of criteria in evaluating customer’s trust towards online SNSs sellers. The results of FAHP were then compared against the result of AHP, which both methods’ results similarities and differences were also presented and discussed.

1. Introduction
Social commerce allows sellers to form relationships with customers via social network sites (SNSs) as the business platform. Appears to have intersected with Electronic Commerce model, this platform allows possible interaction, including buying and selling both physical and non-physical items [1]. A survey conducted by the Malaysian Communications and Multimedia Commission (MCMC) reveals that 51.2% of Malaysian have conducted their buying and selling activities through online shopping platforms [2]. The SNSs have become popular online shopping platforms as a result of fast response and interaction between customers and sellers as compared to traditional e-commerce. User-generated content allows the customer to write reviews on the sellers via text, picture and videos. This feature will increase other customers’ confidence in the sellers when they read those reviews.

However, despite the growth of social commerce, trust remains the main issue when online shopping. Among the main concerns are fraud, fake online sellers, exposure of their personal details and misuse of personal data for marketing purposes. Furthermore, in social commerce, there is no physical interaction involved between the customers and sellers. The inability of the customers to experience the product directly forces them to depend on reviews written by others for a purchase decision. Therefore, managing customer trust is one of the compelling factors in determining the success of social commerce.

Various studies had been conducted mainly using statistical analysis approach to investigate factors influencing customer’s trust in social commerce from different perspectives. The focus of the investigation is categorised into two categories: (1) to assist sellers in gaining trust from the customers
through the implementation of the identified factors [3–7] and (2) to help customers in evaluating the trustworthiness of sellers prior in deciding for online purchase [7–9].

While there are multiple influencing factors affecting customer trust that have been identified in the literature, trust can be considered as a multi-criteria decision making (MCDM) problem. In MCDM, several criteria are taken into consideration to structure the problem in presenting the decision-making process. The structure ensures that MCDM will support the way decision-makers solving the problems. Although various studies have been discussed to identify the influence criteria in evaluating trust in Social Commerce, there has been little or no study using an MCDM process.

Analytic Hierarchy Process (AHP) is an MCDM approach that incorporates both quantitative and qualitative techniques[10]. AHP requires a subjective assessment to evaluate the value of factors by using the judgment of experts. Based on the importance, the parameters that will govern the decision-making process are defined and prioritised by AHP. AHP resembles human analytical thinking in decision making, where analysis is performed in a hierarchical structure. In addition, all the parameters to be weighed in the decision-making process will not be treated equally but based on their relative weight [11]. By providing consistency checks on the evaluation of the experts, AHP reduces bias in the decision-making process.

The Fuzzy AHP (FAHP) method is an extension of the AHP method, which the calculations made are similar but crisp values used are translated into triangular fuzzy numbers \((l, m, u)\). This method is relatively more effective in making comparisons compared to traditional AHP because FAHP supports linguistic values that are used by humans[12]. By using FAHP, a membership function can be produced that can define the degree of possibility of the value which crisp number does not provide [13].

Several studies conducted previously to investigate the effectiveness of FAHP compared with AHP due to its ability to handle fuzziness and vagueness in decision making. The selection of the method depends on the characteristics of information and decision-makers [14,15]. If the information is certain, the AHP method should be applied. Otherwise, FAHP should be adapted, particularly when involving linguistic evaluation. Since linguistic evaluation is applied in this study, the main objectives are proposed:

(a) to determine the priority of criteria and sub-criteria for determining the importance of factors in evaluating trust on Online SNSs sellers using FAHP.

(b) to present a comparative analysis between AHP and FAHP to evaluate the effectiveness of both techniques.

The analysis of FAHP will be presented in the next section. The results are then compared to the AHP analysis to evaluate the differences in results between these two analyses. Finally, the study will discuss the findings and conclusions of these techniques.

2. Methodology

The methodology applied in this study was formulated in six stages:

1. Determine the relative importance of criteria and sub-criteria using pairwise comparison.
2. Develop a fuzzy judgment matrix by and aggregated the judgement using geomean and convert the crisp values into fuzzy values.
3. Determine the consistency ratio to measure the inconsistencies in the judgement. The pairwise comparison will be repeated if the consistency index exceeds the threshold values of 0.10.
4. Perform the defuzzification procedure in order to derive the aggregate crisp judgement matrices.
5. Determine the weights and ranking for criteria and sub-criteria to determine the priority.
6. Compare the derived results with results from the AHP technique.

2.1. Determination of the relative importance for criteria and sub-criteria

A questionnaire is designed based on the hierarchical structure in Table 1 in the form of pairwise comparison. An AHP questionnaire format (Figure 1) adopting the nine-point rating scales indicates
the relative importance of all criteria and sub-criteria in the same hierarchy. The questionnaire was completed by 15 respondents who had experience in doing the transaction with online SNSs sellers at least once in every three months.

Table 1. Criteria and sub criteria

| Criteria                        | Sub Criteria                  |
|---------------------------------|------------------------------|
| E-Wom (EW)                      | Positive Valence (EW1)       |
|                                 | Negative Valence (EW2)       |
|                                 | E-WoM Content (EW3)          |
| Social Commerce Constructs (SCC)| Recommendation (SCC1)        |
|                                 | Rating (SCC2)                |
| Information Quality (IQ)        | Accuracy (IQ1)               |
|                                 | Relevance (IQ2)              |
|                                 | Completeness (IQ3)           |
|                                 | Currency (IQ4)               |
|                                 | Understandability (IQ5)      |
|                                 | Format (IQ6)                 |
| People (P)                      | Transaction Safety (P1)      |
|                                 | Reputation (P2)              |
|                                 | Propensity to Trust (P3)     |


Fig 1. Sample of AHP questionnaire

2.2. Development of Fuzzy Judgement Matrix

After 15 respondents completed their evaluation, their judgement is aggregated using the geometric mean [16]. Next, the aggregated AHP comparison matrix is transformed into a Fuzzy Scale AHP value listed in Table 2 to construct the fuzzy judgement matrices. The FAHP scale has three values: the lowest value ($l$), middle value ($M$), and the highest value ($U$). Table 3 shows the fuzzy judgment matrix for criteria and Table 4 presents the matrix for sub-criteria $P$.

Table 2. Fuzzy Triangular Scale

| Saaty Scale | Definition               | Fuzzy Triangular Scale |
|-------------|--------------------------|------------------------|
| 1           | Equally Important        | (1,1,1)                |
| 2           | The intermittent values  | (1,2,3)                |
| 3           | Weakly Important         | (2.3,4)                |
| 4           | between two adjacent scales | (3,4,5)              |
| 5           | Fairly Important         | (4,5,6)                |
| 6           | Absolutely Important     | (9,9,9)                |
| 7           | Strongly Important       | (6,7,8)                |
| 8           |                          | (5,6,7)                |
Table 3. Aggregated fuzzy judgment matrix for criteria

| Criteria | EW          | SCC          | IQ          | P         |
|----------|-------------|--------------|-------------|-----------|
| EW       | (1.00, 1.00, 1.00) | (0.75, 0.89, 1.06) | (0.90, 1.07, 1.21) | (0.82, 0.94, 1.05) |
| SCC      | (1.14, 1.12, 1.11) | (1.00, 1.00, 1.00) | (1.04, 1.31, 1.56) | (0.87, 0.94, 1.03) |
| IQ       | (0.64, 0.77, 0.95) | (0.64, 0.77, 0.96) | (1.00, 1.00, 1.00) | (0.66, 0.74, 0.83) |

$\lambda_{max}=3.05$, $CR = 0.04$

Table 4. Aggregated fuzzy judgement matrix for sub-criteria $P$

| Sub criteria | P1                          | P2                          | P3                          |
|--------------|-----------------------------|-----------------------------|-----------------------------|
| P1           | 1.00, 1.00, 1.00              | 1.22, 1.50, 1.81              | 1.10, 1.30, 1.46             |
| P2           | 0.55, 0.67, 0.82              | 1.00, 1.00, 1.00              | 0.83, 1.03, 1.28             |
| P3           | 0.66, 0.77, 0.91              | 0.84, 1.06, 1.29              | 1.00, 1.00, 1.00             |

$\lambda_{max}=3.05$, $CR = 0.04$

2.3. Consistency Ratio

Purpose of Consistency Ratio (CR) theory is to evaluate the accuracy of decisions made by experts. The judgement is considered consistent if the value falls within the range. If the inconsistency of judgement occurs, the pairwise comparison assessment needs to be reviewed and improved. The consistency value is calculated as $CR=CI/RI$, where the consistency index ($CI$) is formulated as $CI = \frac{\lambda_{max} - n}{n-1}$.

Random Index (RI) listed in Table 5 is the random consistency index that depends on the size of the matrix (n) and $\lambda_{max}$ represents the principal eigenvalue of the judgement matrix. In this study, the pairwise comparison was consistent with the CR values less than 10%, which the overall mean CR for all the criteria and sub-criteria is 0.005.

Table 5. Random Consistency Index

| n  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|----|---|---|---|---|---|---|---|---|---|----|
| RI | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

2.4. Defuzzification

The objective of defuzzification is to perform fuzzy aggregation by converting fuzzy values into crisp scores. After the fuzzy aggregation procedure, aggregate crisp judgement is established for all criteria and sub-criteria. The aggregate crisp judgement matrix for criteria I is shown in Table 6. Meanwhile, Table 7 shows the aggregate crisp judgement matrix for sub-criteria $P$.

Table 6. Aggregated crisp judgement matrix for criteria

| Criteria | EW  | SC  | IQ  | P   |
|----------|-----|-----|-----|-----|
| EW       | 1.00 | 0.90 | 1.06 | 0.94 |
| SC       | 1.12 | 1.00 | 1.30 | 0.94 |
| IQ       | 0.78 | 0.79 | 1.00 | 0.74 |
| P        | 1.08 | 1.05 | 1.36 | 1.00 |

Table 7. Aggregated crisp judgement matrix for sub criteria $P$

| Sub criteria | P1 | P2 | P3 |
|--------------|----|----|----|
|              |    |    |    |
2.5 Determination weights and ranking using FAHP

The priority weights (local and global weights) for criteria and sub-criteria are determined for comparison within the same hierarchical structure. The criteria and sub-criteria are ranked based on the calculated priority weights to represent the importance level. Figure 2 illustrates the weights for all criteria where the weight vectors for EW, SCC, IQ and P are \( W_G = (0.2438, 0.2707, 0.2066, 0.2789) \) accordingly. This result confirms that the most important criteria in evaluating trust on online SNSs seller are People and Social Commerce constructs. E-WoM and Information Quality are the next essential attributes.

| Criteria | Local | Global 1 | Global 2 |
|----------|-------|----------|----------|
| P1       | 1.00  | 1.51     | 1.29     |
| P2       | 0.68  | 1.00     | 1.05     |
| P3       | 0.78  | 1.06     | 1.00     |

Figure 2. Weightage for criteria

The results for global weights in Figure 3 exhibit the SCC1(17.3%) and P1 (11.3%) are the most important sub-criteria in contrast to other sub-criteria. These followed by SS2 (9.7%), EW2 (9.4%), P3 (8.5%), P2 (8.1%) and EW3(7.4%). Therefore, these sub-criteria are the key important factors to be considered in evaluating trust towards online SNSs sellers. The other sub-criteria for Information Quality just barely contributed as its weight less than 5%.

Figure 3. Weightage for sub-criteria
2.6. Comparison analysis between FAHP and AHP

The variation of outcomes between FAHP and AHP approaches are compared by utilising peculiar criteria ranks for each method. The synthesis analysis of the AHP method has been conducted in previous works [17]. Table 8 shows the comparison of global weights between FAHP and AHP.

The criteria ranking order appears to be analogous where four criteria were assigned the same weights and rank in both models. Having said that, the differences became more apparent at the sub-criteria level. For example, P2 and have different ranks for AHP but were assigned the same ranks by FAHP. The same goes for IQ4 and IQ5. Both models assigned the most important sub-criteria SCC1, P1, SCC2 and EW2 exactly in the same order. The least important factor which is sub-criteria for IQ had found similar as identified in AHP. The results show small differences in weights values calculated by FAHP and AHP, which is less than 1% and the average value is only 0.12%.

| Criteria | Fuzzy AHP | AHP | Difference Values |
|----------|-----------|-----|-------------------|
| EW       | 24.38%    | 3   | 24.38% 3         | 0.00% |
| SCC      | 27.07%    | 2   | 27.07% 2         | 0.00% |
| IQ       | 20.66%    | 4   | 20.66% 4         | 0.00% |
| P        | 27.89%    | 1   | 27.89% 1         | 0.00% |
| Sub Criteria |   |     |                  |     |
| EW1      | 7.61%     | 7   | 7.92% 6         | 0.31% |
| EW2      | 9.35%     | 4   | 9.12% 4         | 0.23% |
| EW3      | 7.41%     | 8   | 6.96% 7         | 0.45% |
| SCC1     | 17.30%    | 1   | 17.28% 1        | 0.02% |
| SCC2     | 9.77%     | 3   | 9.72% 3         | 0.05% |
| IQ1      | 4.07%     | 9   | 3.99% 8         | 0.08% |
| IQ2      | 2.73%     | 14  | 2.94% 11        | 0.21% |
| IQ3      | 3.33%     | 12  | 3.57% 10        | 0.24% |
| IQ4      | 3.82%     | 10  | 3.78% 9         | 0.04% |
| IQ5      | 3.72%     | 11  | 3.78% 9         | 0.06% |
| IQ6      | 2.98%     | 13  | 2.94% 12        | 0.04% |
| P1       | 11.30%    | 2   | 11.20% 2        | 0.10% |
| P2       | 8.10%     | 6   | 8.40% 5         | 0.30% |
| P3       | 8.51%     | 5   | 8.40% 5         | 0.11% |
| Average Difference Value | 0.12 |     |                  |     |

3. Conclusion

The purpose of the current study was to determine the priority of criteria and sub-criteria for determining the importance of factors in evaluating trust on Online SNSs sellers using the FAHP method. Consequently, a comparative analysis between AHP and FAHP was conducted to evaluate the effectiveness of both techniques. A multistage methodology applied in this research revealed that FAHP is pertinent for fuzzy environments than the AHP. The former is appropriate if uncertainty exists in the judgement evaluation while the latter is recommended when judgements are to be made. Comparatively, the findings reported here shed new light on the FAHP advantage in weighting criteria to evaluate customers' trust towards online SNSs sellers. The results, however, would not provide much difference from the AHP even though the issues on vagueness and imprecise judgement were discussed in previous literature.

The outcome of this study provides insights towards the online SNSs sellers in improving their business and gain trust from their new and existing customers. On the other hand, customers can evaluate the trustworthiness of online SNSs sellers based on the importance of factors. From academic perspectives, the study aligns with findings from previous studies that prove neither FAHP nor AHP is better than each other [12,18]. The simplicity of AHP, which evaluates using one number compared
to three numbers in Fuzzy AHP, can eliminate errors in the calculation during analysis [19]. In future, this study can be integrated with other MCDM techniques such as fuzzy set theories, Delphi, sensitivity analysis and TOPSIS for better insights in prioritising the importance of trust factors in evaluating online SNSs sellers.

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