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The Selection of Social Networking Sites Using Fuzzy Analytical Hierarchy Process

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ABSTRACT

Social networks have penetrated internet users of all ages and become an important means of communication and entertainment, including in the student community. As the number of social networking sites grows, the selection of networking sites including Twitter, Facebook, Google+, Instagram and so on, is becoming increasingly critical for website operators, advertisers and even university students. This platform is becoming essential for business performance in dealing with modern generations to increase revenues and profits. Moreover, as the number of social networks increases, the user's tendency to make a choice is difficult. The market for social networking sites is highly competitive and changes in line with the trend. The objective of the research is to rank the most popular social networking sites Facebook, Instagram and Twitter among university students based on certain criteria. Therefore, this study proposes a solution by developing a mathematical technique which is the Fuzzy Analytical Hierarchy Process (FAHP) to estimate the relative importance of site criteria used in deciding the social site. The result of this study shows that Instagram has the first ranking followed by Facebook and Twitter. Functionality is the important criteria chosen with Renenue-generating opportunities as the preferred sub-criteria. Content is the second criteria concerned followed by Usability and Privacy.

Keywords: *Fuzzy Analytical Hierarchy Process (F-AHP); Social Networking Sites; Ranking; Criteria.*

1. INTRODUCTION

Today online social networking sites (SNS) are expanding rapidly in use both personally and professionally. The adoption of digital channels is becoming more prominent around the world, with people of different cultures gradually accessing the internet to engage in networking sites. Communication using SNS is becoming a new way of life for individuals. Nowadays, the rapid growth of social network use has made a magnificent channel for offering various services, increasing the beneficiary of services and business.

The advent of the internet has allowed us to communicate with people around the world with a few clicks of a button. Together with the emergence of smartphones and applications combined with social networking technology, interaction with this digital platform is becoming the best connection in human life. As the number of SNS grows, the selection of networking sites such

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as Twitter, Facebook, Google+, Instagram and so on, is becoming increasingly critical for website operators and advertisers. SNS are prominent among university students, and often become a problem to them also in choosing the best social site. From time to time, there are new emergences of SNS popping up in the middle of popular sites, while some existing ones are dying out. Given the choice of so many SNS, how do users decide which one to sign up for and continue as active users. The networking companies are also eager to know what makes their online sites desirable for users. The advertisers are keen to understand why people decide the choice because it would encourage them to devise an effective strategy for social media interaction. Therefore, in an attempt to provide this question with a much-needed answer, an overview of how users decide between various SNS is necessary.

Nowadays, Facebook, Twitter, Instagram and Snapchat are the top four social media sites. According to Treadaway & Smith [1] Facebook, the largest and most widely used social networking site in the world, was the first to reach 1 billion user accounts. The market for SNS is highly competitive and changes in line with the trend. Criteria are therefore the important aspects that need to be considered when making a decision. Each of the networks has its own criteria that can attract users' preferences to social sites. In addition, different people have different tastes and preferences. This study seeks to identify the criteria that affect the students the most when selecting a social network. This study also aims to rank the three influential SNS namely Facebook, Instagram and Twitter.

2. LITERATURE REVIEW

Boyd and Ellison [2] defined Social Networking Sites (SNS) as web-based services that encourage individuals to create a public or semi-public profile within a limited context, provide a good list of other users with whom they share a connection and display their list of connections as well as those generated by others within the system. Kwon and Wen [3] defined SNS as websites that allow people to build online relationships through the collection and sharing of useful information with others. Pavlova et al. [4] described this medium as trendy among students and can be a valuable tool for learning. According to Greenhow and Lewin [5] the virtual practice communities built through SNS that required students to join and collaborate on global networks that transcend geographical boundaries make interaction, cooperation and participation improved. A study by Tang and Ngerng [6] using the AHP model found out that the students in a certain university in Malaysia preferred Facebook over Twitter. Swarnakar et al. [7] used a fuzzy logic approach to examine the preferred SNS relationship. The aim of this article is to analyse the strength of socio-demographic factors that encourage a user to send a friend's request to the SNS. Five attributes, namely Mutual Friends, Age, Sex, School / College and Relationship Status, are identified as factors contributing to the study. The authors concluded that the important factors for a person to send a friend's request to an unknown person are the relationship status, age and gender factors.

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3. METHODOLOGY

3.1 Data Collection

This research focused on the selection criteria for the most popular SNS among students. The social networks chosen are Facebook, Instagram and Twitter because of their popularity among students. The data used in this study are the primary data collected by questionnaires from final year Bachelor Degree of Mathematics Management students from UiTM Perlis. The questionnaire is designed to display the main criteria, sub-criteria, and alternatives (Facebook, Instagram, and Twitter) as individual pairs. The respondents were asked to compare the pair on a scale ranging from 1 to 9 T.L Saaty [8]. 1 being "equally important" to 9 being "completely important". The questionnaires were distributed to 12 final year Bachelor Degree of Mathematics Management students from UiTM Perlis who are active users of Facebook, Instagram, and Twitter. Of the 12 respondents, only 3 were selected. They were the respondents who spend at least 6 hours a day and an active user of Facebook, Instagram and Twitter. In this research, the Fuzzy Analytic Hierarchy Process (FAHP) method was used to rank the relative importance of selection criteria in deciding on the most popular social networking sites. The criteria are Content, Functionality, Usability and Privacy. The description of the criteria is shown in Table 1. Each main criteria contains 2 sub-criteria as shown in Table 2.

Table 1: The description and abbreviation of the main criteria

Main Criteria	Description	Abbreviation
Content	The quality of social networking sites in performing their website and the appropriateness of content	C
Functionality	The capability of the website to provide customer preferences and give appropriate set of functions for specified tasks and user objectives	F
Usability	The expectations and specifications designed to ensure the website environment is easy to use	U
Privacy	Degree to which the service is safe and protects customer information	P

3.2 Data Analysis

This study will develop the method by employing the Fuzzy Analytic Hierarchy Process (FAHP). Microsoft Excel was used to analyse the data from the questionnaire. Before the data were analysed, the hierarchical diagram was formed in order to observe the problem clearly. The first level of the hierarchy is the goal of the study, while the second level of the hierarchy is the main criteria and the third level of the hierarchy is the sub-criteria used to select the Social Networking Sites. Each criterion has 2 sub-criteria. Next, the fourth level of the hierarchy is the alternatives of the Social Networking Sites that need to be evaluated by the decision makers. The hierarchical diagram is shown in the Figure 1.

In fuzzy AHP, the comparison of criteria is performed through the linguistic variables, which are represented by triangular fuzzy numbers (TFNs). Table 3 presents a fuzzy version of the common fuzzy scale of T.L.Saaty [8] in which the result of each comparison is shown as a

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triangular fuzzy number and its inverse equivalent. A triangular fuzzy number is represented by (lower value *l*, middle value *m*, upper value *u*).

Table 2: The description and abbreviation of the sub-criteria

Main Criteria	Sub-Criteria	Description
Content	Advertisements	A notice or announcement in a website on promoting or publicizing
	Website Attractiveness	A key the online role enhancing purchase among the consumers
Functionality	Content Management	Processes and technologies that supports the collection, managing, and publishing of information in any form or medium
	Revenue-generating opportunities	Opportunities to generate revenue in business
Usability	Ease of use	The easy use and handling of social site
	Site Performance	The speed in which web pages are downloaded and displayed on the user's web browser.
Privacy	Privacy Settings	Allow users to limit who can access your profile and what information visitors can see.
	Information Security	Protected against the unauthorized use of information

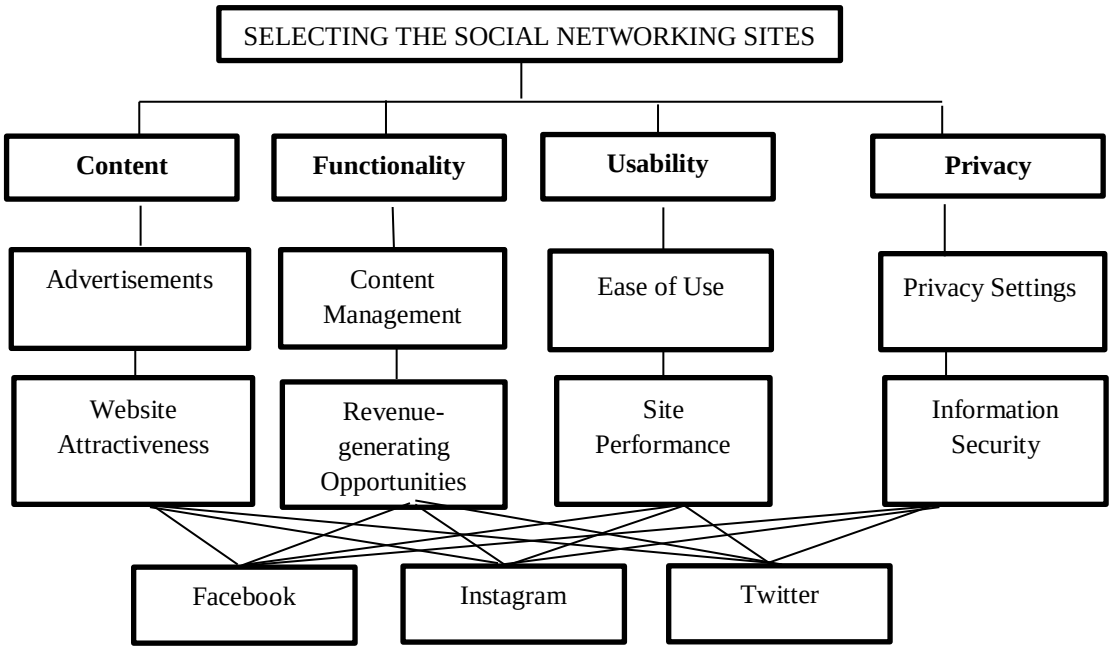

Figure 1: Hierarchical diagram in social networking sites selection

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Table 3: Linguistic terms and the corresponding triangular fuzzy numbers

Saaty Scale	Linguistic Variable	Triangular Fuzzy Number
1	Equally Important	(1,1,1)
2	Intermediate	(1,2,3)
3	Weakly Important	(2,3,4)
4	Intermediate	(3,4,5)
5	Strongly Important	(4,5,6)
6	Intermediate	(5,6,7)
7	Very Strongly Important	(6,7,8)
8	Intermediate	(7,8,9)
9	Completely Important	(9,9,9)

For example, if the decision-maker states "Criterion 1 (C1) is Strongly Important than Criterion 2 (C2)", then it takes the fuzzy triangular scale as (4,5,6). In contrast, the comparison comparability of C2 to C1 will obtain the fuzzy triangular scale as $\left(\frac{1}{6},\frac{1}{5},\frac{1}{4}\right)$.

3.2.1 Consistency Test

The results of pairwise comparisons may vary due to the uncertainty of expert evaluations. The AHP method proposes a test of consistency and measures to prevent this issue. In the Fuzzy AHP approach, the same consistency test was applied. To assess how consistent are the respondents in giving their opinion, a consistency index (CI) for each matrix is calculated and then compared to the random index (RI). The consistency ratio (CR) was then obtained by dividing the CI by RI. According to T.L Saaty [8] and T.L Saaty [9] the matrix is considered satisfactory if its CR is less than 0.1. As indicated in Table 4 the judgements of the three experts were consistent since all matrices had the CR value of less than 0.1.

Table 4: The consistency ratio of the three experts

Expert	Consistency Ratio (CR)
Q^1	0.009
Q^2	0.087
Q^3	0.008

3.2.1 Determining the Weights

The weight of criteria, sub-criteria and weight of alternative with respect to each criterion were calculated as follow:

Step 1: The pairwise comparison of the criterion matrix is constructed for each expert. The preferences of the expert for each survey were averaged to get a new pairwise comparison matrix.

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$$A=\begin{bmatrix}(a_{11}^k,b_{11}^k,c_{11}^k) & (a_{12}^k,b_{12}^k,c_{12}^k)\ldots\left(a_{1n}^k,b_{1n}^k,c_{1n}^k\right)\\ a_{21}^k,b_{21}^k,c_{21}^k & (a_{22}^k,b_{22}^k,c_{22}^k)\ldots\left(a_{2n}^k,b_{2n}^k,c_{2n}^k\right)\\ a_{31}^k,b_{31}^k,c_{31}^k & (a_{32}^k,b_{32}^k,c_{32}^k)\ \ldots\ \left(a_{3n}^k,b_{3n}^k,c_{3n}^k\right)\end{bmatrix}=\left[d^k{}_{ij}\right]$$ where $\tilde{d}_{ij}^{\,k}$ indicates the k[th]

decision maker's preference of i[th] criterion over a j[th] criterion, via fuzzy triangular numbers.
Step 2: Calculate the Geometric Mean of the fuzzy comparison values $\tilde{r}_i$

$$\tilde{r}_i=\left(\prod_{j=1}^{n}\tilde{d}_{ij}\right)^{1/n},\ i=1,2,...,n$$ where n is the number of criteria. (1)

Step 3: Calculate the fuzzy weight of criterion i , [$\tilde{w}_i$], multiply each $\tilde{r}_i$ with this reverse vector.

$$W_i=\tilde{r}_i\times s^{-1}\quad=(a_i,b_i,c_i)\qquad\text{where } s^{-1}=\left(\frac{1}{\sum c_n},\frac{1}{\sum b_n},\frac{1}{\sum a_n}\right)\tag{2}$$

Since $\tilde{w}_i$ are still fuzzy triangular numbers, they need to de-fuzzified by using the Centre of Area method proposed by Chou and Chang [10], via applying the Eq. (3).

$$M_i=\frac{lw_i+mw_i+uw_i}{3}\tag{3}$$

Step 4: Finally, normalize the de-fuzzified weight of criterion M_i using Eq. (4)

$$N_i=\frac{M_i}{\sum_{i=1}^{n}M_i}\tag{4}$$

3.2.2 Ranking

The ranking is determined from the score obtained by multiplying the weight of the criteria by the weight of each alternative with respect to the criteria.

4. RESULT AND DISCUSSION

To determine the selection criteria for SNS, the data from the three experts were collected through the survey to voice their opinion. Between the three experts, the preferences for each survey were averaged. Once completed, a new pairwise comparison matrix is created for the criteria. Table 5 shows the average pairwise comparison of the 3 experts.

Calculation of the Geometric Mean of fuzzy comparison value $\tilde{r}_i$ is done by Eq. (1). The result is as shown in Table 6.

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Table 5: Pairwise comparison matrices for the criteria

Criteria	Content	Functionality	Usability	Privacy
Content	(1.000,1.000,1.000)	(0.437,0.456,0.483)	(4.333,4.667,5.000)	(4.000,4.667,5.333)
Functionality	(3.333,4.000,4.667)	(1.000,1.000,1.000)	(5.333,6.333,7.333)	(5.333,6.333,7.333)
Usability	(0.437,0.454,0.481)	(0.137,0.159,0.189)	(1.000,1.000,1.000)	(1.333,1.667,2.000)
Privacy	(0.423,0.437,0.456)	(0.140,0.164,0.198)	(0.750,0.770,0.833)	(1.000,1.000,1.000)

Table 6: Geometric means of fuzzy comparison values

Criteria	$\tilde{r}$		
	L	*m*	*u*
Content	1.659	1.775	1.894
Functionality	3.120	3.559	3.980
Usability	0.532	0.589	0.653
Privacy	0.460	0.485	0.524
Total	5.771	6.408	7.051
Reverse (power of -1)	0.173	0.156	0.142
Increasing Order	0.142	0.156	0.173

The fuzzy weight of criterion *i* ($\tilde{w}_i$), is calculated using Eq. (2). The result is shown in Table 7.

Table 7: Relative fuzzy weights of each criterion

Criteria	$\tilde{W}_i$		
	L	*M*	*u*
Content	0.236	0.277	0.328
Functionality	0.443	0.555	0.689
Usability	0.076	0.092	0.113
Privacy	0.065	0.076	0.091

The fuzzy weight of each criterion is then de-fuzzified and normalized by applying Eq. (3) and Eq. (4) respectively. Table 8 shows the value of de-fuzzified weight M_i and the normalized M_i that is N_i.

Table 8 shows that the highest weight is Functionality, which means that it is the most impactful criterion in selecting SNS with a relative normalized weight of 0.555. The result proves that the capability of the website to provide customer preferences and give an appropriate set of functions for specified tasks to meet user objectives is the top priority in choosing the SNS. Content is the second criterion that concerns the users followed by Usability and Privacy.

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Privacy scores the lowest weight of 0.076. This shows that the users seem to care less about the safety of the service and the protection of customer information.

Table 8: Non fuzzy and normalized relative weights of criteria

Main Criteria	M_i	N_i
Ccontent	0.280	0.276
Functionality	0.562	0.555
Usability	0.093	0.092
Privacy	0.077	0.076

Table 9: Non fuzzy and normalized relative weights of sub-criteria

Content	Functionality	Usability	Privacy
Advertisements 0.602	Content Management 0.383	Ease of use 0.536	Privacy Settings 0.333
Website Attractiveness 0.398	Revenue-generating opportunities 0.617	Site Performance 0.464	Information Security 0.667

Table 9 shows the prioritization of the sub-criteria. For sub-criteria of content, the respondents agreed that advertisement is the top priority (0.602) followed by website attractiveness (0.398). For the sub-criteria functionality, the respondents indicated that revenue-generating opportunities (0.617) are the first priority followed by content management (0.383). For sub-criteria usability, the respondents choose ease of use (0.536) over the site performance (0.464). For the privacy sub-criteria, the respondents considered information security as the top priority (0.667) followed by privacy setting (0.333). All the prioritizations of sub-criteria concurred with the finding done by Tang and Ngerng [6].

In order to rank the SNS, the weight of each alternative with respect to each criterion is needed. The same procedure is used to determine the weights of each alternative with respect to each criterion.

Table 10 displays the weight of alternatives with respect to each criterion. Let's N_{ij} denote the weight of alternative *i* with respect to criteria *j* where i=1,2,3 and j=1,2,3,4.

Table 10: Non-fuzzy and normalized relative weights N_{ij} of alternative with respect to criteria

	Criteria *j*			
Alternatives *i*	Content	Functionality	Usability	Privacy
Facebook	0.254	0.235	0.356	0.231
Instagram	0.563	0.621	0.563	0.552
Twitter	0.183	0.144	0.080	0.217

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The ranking is determined from the score obtained by multiplying the weight of the criteria by the weight of each alternative with respect to the criteria.

Facebook =0.276(0.254) +0.555(0.235) +0.092(0.365)+0.076(0.231)=0.251

Instagram =0.276(0.563) +0.555(0.621)+0.092(0.563)+0.076(0.552)=0.594

Facebook =0.276(0.183) +0.555(0.144)+0.092(0.080)+0.076(0.217)=0.155

The result in Table 10 shows that Facebook has consistent weightage with respect to each criterion with Usability has a slightly higher weight. However, Instagram has a weightage of more than 0.5 with respect to each criterion that makes it the most preferred SNS among university students (0.594). The second preferred SNS is Facebook (0.251) and Twitter (0.155) ranks the lowest among the three as shown in Table 11. Twitter failed to meet the criteria needed by students as Functionality, Content, Usability and Privacy are concerned.

Table 11: The rank

Alternative	Score	Rank
Facebook	0.251	2
Instagram	0.594	1
Twitter	0.155	3

The result corresponded with the study by Mese and Aydin [11] in Turkey that the most widely used social networks among university students are WhatsApp and Instagram. However, a study by Bicen and Cavus [12] among university students in Northern Cyprus found that Facebook and Live Spaces are the preferred sites. The study by Almadhoun et al. [13] on four public and private universities in Malaysia also found that Facebook is the most popular site with 97% penetration rate. This is probably because Instagram was a relative new player at that time.

5. CONCLUSION

The objective of this research is to determine the most selected criteria considered by students in UiTM Perlis in choosing their preferred SNS. For that reason, three respondents from final year Bachelor in Mathematics Management students at UiTM Perlis who spend at least 6 hours a day and active users of Facebook, Instagram and Twitter were chosen for this study. The criteria used in this study were Content, Functionality, Usability and Privacy. The study found that students put Functionality with sub-criteria revenue-generating opportunities as their top priority in choosing SNS. This means the capability of the website to provide customer preferences and give an appropriate set of functions for specified tasks and user objectives as the most important criteria in choosing the social site. The second criterion that influences the selection of SNS was Content. The respondents preferred to choose it because of advertisements that occur in the social sites. Next, Usability with ease of use is selected as the first priority followed by Privacy. Privacy was the least criteria of concern in choosing SNS among students. In term of sub-criteria in privacy, information security was the main concern compared to privacy setting.

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Based on the research, Instagram dominated the selection of networking sites by students in UiTM Perlis, followed by Facebook and Twitter with functionality plays an important criterion followed by Content, Usability and Privacy. As far as Facebook and Twitter are concerned, this study is consistent with Tang & Ngerng [6] that students preferred Facebook over Twitter. This analysis helps to recognize the vulnerabilities and future social network improvements. Instagram, a relatively new player had already overtaken Facebook and Twitter due to its excellency in fulfilling the needs of the new generation. Instagram was invented in 2010, while Facebook and Twitter were invented in 2004 and 2006 respectively.

In summary, the FAHP model assists decision-makers in choosing the most suitable alternative under complicated conditions. It will help the researchers determine the most favoured criterion and the most appropriate decision based on the alternatives to the chosen decision. Other MCDM approach that can nowadays be used to rank social networking sites such as TOPSIS (Order of Choice Technique Close to Ideal Solution), MAUT (Multi-Attribute Utility Theory), PROMETHEE (Preference Ranking Organization Method for Enrichment of Evaluations) and DEMATEL (Decision Making Trial and Evaluation Laboratory) which are also the possible methods to be applied for the future analysis. Moreover, future researchers may add other social networking sites and also add other appropriate criteria and sub-criteria for the analysis. The researchers may conduct the survey using other respondents, such as academicians. Researchers may modify the location of the study to a specific place and region, or rate social sites using respondents of different age levels.

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