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Selection of Social Networking Sites among Undergraduate Students with AHP-TOPSIS Model

Liew Kah Fai[1], Lam Weng Siew[1], Lam Weng Hoe[1*], Mohd Abidin Bin Bakar[1]

[1]*Department of Physical and Mathematical Science, Faculty of Science, Universiti Tunku Abdul Rahman, Kampar Campus, Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia.*

[*] Corresponding author: whlam@utar.edu.my

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ABSTRACT

Social networks are well established nowadays as the whole world is accessible to the internet. Social networking site provides different features that allow users from around the world to communicate, associate, relate and interact with each other. Facebook, Twitter, Google Plus and Instagram are the most common social networking sites that have been introduced nowadays. The objective of this study is to determine the preferred social networking site among the undergraduate students as well as identify the priority of decision criteria in the selection of social networking sites with the proposed AHP-TOPSIS model. AHP-TOPSIS model is a hybrid of AHP model and TOPSIS model which is an effective tool to tackle the multi-criteria decision making problem. AHP model is responsible to determine the weights of the decision criteria whereas TOPSIS model is adopted to identify the ranking of the social networking sites as well as to select the most preferred social networking sites as the ultimate goal of this study. The results of this study show that Instagram is the most preferred social networking site, followed by Facebook, Twitter and lastly Google Plus. Moreover, privacy is the most important decision criterion in the selection of social networking sites. This study is significant because it helps to identify the most influential decision criterion and also the most favourable social networking site among the undergraduate students. This study can serve as a reference for those less favourable social networking sites to identify their potential improvements so that they can offer better services to their users in the future.

Keywords: Decision Criteria, Ranking, Social Networking Sites, Undergraduate Students

1 INTRODUCTION

In this digital era with rapid development of technology and science, a multiplicity of Social Networking Site (SNS) has been introduced and it continues to evolve nowadays [1]. According to Fuchs [2], SNS is an integrated world wide web-based information, community and communication platform that enables the creation of personal profiles, upload and sharing of multimedia data as well as allowing networking and communication with other users. SNSs combine a number of Internet technologies on one platform and it could be said as the most popular Internet and web application nowadays especially among the younger generations. For instance, Facebook, Twitter, Google Plus and Instagram are the examples of trendy and popular SNSs that have been introduced nowadays.

SNS has become an integral part of communication and lifestyle of people in today's world, attracting attention from all possible Internet users, especially teenagers [3]. However, more SNSs with different functionalities are being introduced nowadays. Hence, it leads to users feel difficult to choose a better SNS. Since the selection of SNSs is a multi-criteria decision making (MCDM) problem, this problem can be solved by the proposed AHP-TOPSIS model. Based on the past studies [4-6], the important decision criteria such as content, functionality, usability, privacy and popularity are considered in this study. Content is defined as the preferred reading or viewing the information that posted by the user's friends [7]. The definition of functionality is the kind of functions provided by the SNSs to the users such as "social browsing" and "social searching" [8]. Usability refers to the SNSs users' chance of remaining loyal [9]. On the other hand, privacy is defined as the security awareness on privacy settings when using the SNSs [10]. Popularity is defined as the diffusion of the social networks [11].

Tang and Ngerng [4] have done a study by using the AHP model to examine how university students select between two popular SNSs, Twitter and Facebook. They considered content, usability, functionality and privacy as the decision criteria in their study. The results showed that privacy is the most influential decision criterion, followed by functionality, usability and content. The study concluded that Facebook is more preferable than Twitter.

Lai and Ngerng [5] have conducted a decision making analysis on selection of the SNSs among the college students by using AHP model. For instance, Facebook, Twitter and Google Plus are treated as the decision alternatives whereas the decision criteria such as privacy, functionality, usability, content and popularity are considered in the study. Based on the results, privacy is the top priority that considered by the college students, followed by functionality, usability, content and lastly popularity. In this study, the best SNS that is considered by college students is Facebook, followed by Twitter and Google Plus.

AHP-TOPSIS aims to tackle MCDM problem and has been extensively applied in the field of adoption cots database components [12], E-learning [13], course selection [14], fast food restaurant selection [15], mobile network operators' selection [16] and supply chain performance system [17]. The objective of this research is to determine the priority of decision criteria among the content, functionality, usability, privacy and popularity in the SNSs selection by using AHP model. After that, the ranking of SNSs with respect to all decision criteria is identified using TOPSIS model.

Based on the past studies, the researchers did not include Instagram as one of the alternatives since Instagram is gaining the popularity nowadays. Hence, this study aims to fill the research gap by determining the most favorable SNS among Facebook, Twitter, Google Plus and Instagram with the proposed AHP-TOPSIS model. The significance of this study is to identify the priority of the decision criteria in the selection of SNSs as well as the best decision alternative based on multiple decision criteria. The structure of the paper is organized as follows. Section 2 demonstrates the data and methodology in this study. Section 4 presents the empirical results. Lastly, concluding remarks are drawn in Section 4.

2 METHODOLOGY

In this study, the proposed AHP-TOPSIS model is illustrated with a case study in Universiti Tunku Abdul Rahman, Malaysia. AHP and TOPSIS are popular types of decision models which solve MCDM

problems. MCDM problems include determining the best alternative or optimal solution by considering multiple criteria [18-35]. AHP-TOPSIS model is proposed in this paper because the hybrid of these two models is capable and effective to identify the weights of the decision criteria as well as the preferred social networking sites. AHP model is used to determine the importance of the decision criteria in terms of weight. On the other hand, the ranking of the social networking sites can be easily obtained by TOPSIS model. Lastly, the best social networking site is identified with respect to all decision criteria by the proposed AHP-TOPSIS model. The target respondents consist of 180 undergraduate students who are the users of SNSs in Malaysia. Figure 1 presents the proposed hierarchical structure for the social networking sites selection with AHP-TOPSIS model.

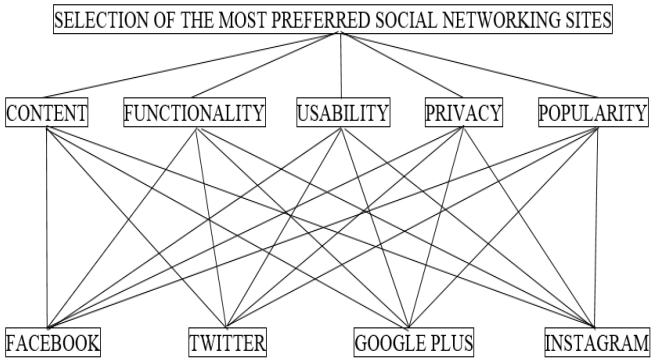

Figure 1. Proposed hierarchical structure for the social networking sites selection with AHP-TOPSIS model.

AHP model is an effective decision making tool that deals with complex decision making involving multiple decision criteria [36-39]. In this study, AHP model is utilized to determine the weights of the decision criteria which consists of the following steps [40-43].

Step 1: Decompose the problem into a hierarchical structure. There are total of three levels for the hierarchy structure, which are goal (first level), decision criteria (second level) and decision alternatives (third level).

Step 2: Gather data from the target respondents according to the relative scale of importance [36-38]. Table 1 shows the ratio scale used for pairwise comparison between two criteria [41, 44].

Table 1 Ratio scale used for pairwise comparison

Scale	Meaning
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Absolute importance
2, 4, 6, 8	Intermediate importance

Step 3: Construct a pairwise comparison matrix (PCM). The *n* decision criteria PCM is as shown below.

$$A=\begin{bmatrix} 1 & c_{12} & \cdots & \cdots & c_{1n} \\ 1/c_{12} & 1 & & & c_{2n} \\ \vdots & & \ddots & & \vdots \\ \vdots & & & \ddots & \vdots \\ 1/c_{1n} & \cdots & \cdots & \cdots & 1 \end{bmatrix} \quad (1)$$

where c_{ij} shows the degree of preference of element *i* to element *j*.

Step 4: Normalize the matrix and determine the relative weights of each decision criterion. The formula to find the weights of the decision criterion is as presented below.

$$w_i = \frac{1}{n}\sum_{j=1}^{n} c_{ij}, \quad i = 1, 2, 3, \ldots, n \quad (2)$$

Step 5: Use the consistency ratio (*CR*) to check the consistency of the PCM. The formula of *CR* is shown below:

$$CR = \frac{CI}{RI} \quad (3)$$

where *CI* is consistency index and *RI* is random index [39]. The degree of consistency in the PCM is acceptable if the *CR* is less than or equal to 0.10 [41]. This indicates that the AHP result is reliable and acceptable.

TOPSIS is a popular type of MDCM model. MCDM model helps to solve MCDM problem [45-47]. In this research, TOPSIS model is utilized to identify the ranking and choose the best alternative among SNSs. In TOPSIS model, the best alternative seeks to have the shortest path to the positive ideal solution (PIS) and the longest path from the negative ideal solution (NIS) [48-50]. The TOPSIS model is carried out as follows [48-50]:

Step I: Construct a decision matrix $(x_{ij})_{m\times n}$.

$$(x_{ij})_{m\times n} = \begin{array}{c} \\ L_1 \\ L_2 \\ \vdots \\ \vdots \\ L_m \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & \cdots & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & & & x_{2n} \\ \vdots & \vdots & \ddots & & \vdots \\ \vdots & \vdots & & \ddots & \vdots \\ x_{m1} & \cdots & \cdots & \cdots & x_{mn} \end{bmatrix} \end{array} \quad (4)$$

where *i* = alternative index $(i = 1, 2, 3, \ldots\ldots, m)$

j = criterion index $(j = 1, 2, 3\ldots\ldots, n)$

C_j = criterion $(j = 1, 2, 3 \ldots\ldots, n)$

L_i = alternative $(i = 1, 2, 3, \ldots\ldots, m)$

Step II: Construct a normalized decision matrix.

The normalized value r_{ij} is expressed as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{5}$$

Step III: Determine the weighted normalized decision matrix. The formula for calculating the weighted normalized value v_{ij} is shown below:

$$v_{ij} = w_j \times r_{ij}, \; j = 1, 2, 3, \ldots\ldots, n; \; i = 1, 2, 3, \ldots\ldots, m \tag{6}$$

where w_j = weights of the criterion j

Step IV: Identify the PIS and NIS.

$$\text{PIS} = \left\{ v_1^+, v_2^+, \ldots\ldots, v_n^+ \right\} \tag{7}$$

where $v_j^+ = \{(\max v_{ij} \mid i \in I), (\min v_{ij} \mid i \in I')\}$

$$\text{NIS} = \left\{ v_1^-, v_2^-, \ldots\ldots, v_n^- \right\} \tag{8}$$

where $v_j^- = \{(\min v_{ij} \mid i \in I), (\max v_{ij} \mid i \in I')\}$

Step V: Compute the alternatives' separation distance from the PIS (S^+) and NIS (S^-).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_j^+ - v_{ij})^2}, \; i = 1, 2, 3, \ldots\ldots, m \tag{9}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_j^- - v_{ij})^2}, \; i = 1, 2, 3, \ldots\ldots, m \tag{10}$$

Step VI: Compute the alternatives' relative closeness coefficient respect to the ideal solutions (c_i).

$$c_i = \frac{s_i^-}{\left(s_i^+ + s_i^-\right)}, \; 0 \le c_i \le 1 \tag{11}$$

Step VII: Rank the alternatives according to the alternatives' relative closeness coefficient. The largest value of c_i denotes the alternative is the best decision alternative. In other words, the alternative that has the longest path from the NIS and the shortest path to the PIS will be the best alternative.

3 EMPIRICAL RESULTS

The priority of decision criteria in the selection of SNSs is presented in Figure 2.

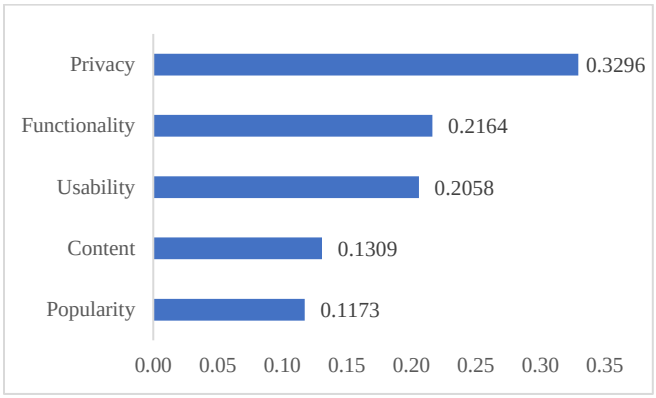

Figure 2. Priority of decision criteria in the selection of social networking sites.

As shown in figure 2, the weights for privacy, functionality, usability, content and popularity are 0.3296, 0.2164, 0.2058, 0.1309 and 0.1173 respectively. Based on the results, privacy is identified as the most influential decision criterion, followed by functionality, usability, content and popularity. The validation of the model has been done by checking the consistency ratio of the decision criteria' PCM. In this research, the consistency ratio is 0.0019 which is well below 0.1000. Thus, it can be said that the inconsistency is not exhibited in the PCM. Hence, the result of this study is acceptable and reliable.

Figure 3 to Figure 7 demonstrate the preference of SNSs with respect to each decision criterion.

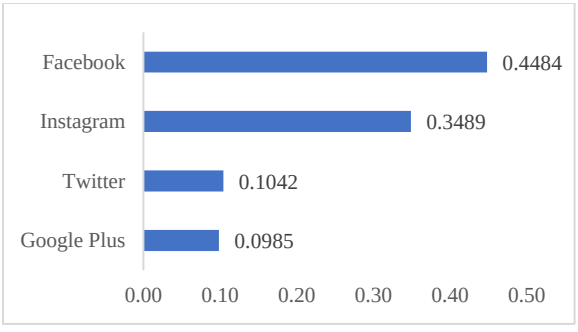

Figure 3. Preference of social networking site based with respect to content.

Figure 3 shows that Facebook and Instagram have higher rankings with respect to content which are more appealing and interesting. According to Rao [51], Facebook is an important source of information that users can read the latest news and know exactly what is happening around the world. This shows the content of Facebook is meaningful and it provides knowledge to the users making it to be ranked as the top.

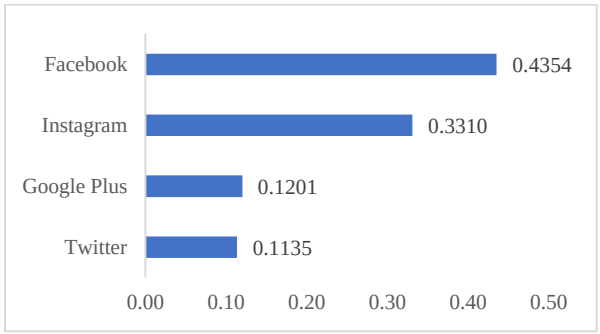

Figure 4. Preference of social networking site with respect to functionality.

Based on functionality, Facebook is once again ranked as the top, followed by Instagram, Google Plus and Twitter. This is due to a variety of functions being offered by Facebook to the users and the functions providing a platform for the users to interact with friends, join networks and groups, share pictures and videos, create group discussion, create an event, promote products, write comments and read the news.

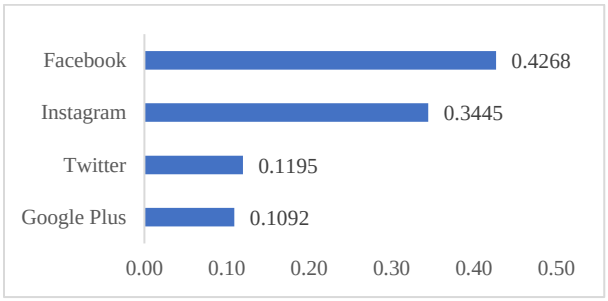

Figure 5. Preference of social networking site with respect to usability.

In terms of usability, Facebook and Instagram have once again ranked before Twitter and Google Plus. The reason why Facebook is gaining worldwide popularity is partly due to its user friendly nature as it is said to be the easiest to use website and even a new user can understand all the features easily [51]. Facebook provides easy posting and sharing photos and video tools for the user.

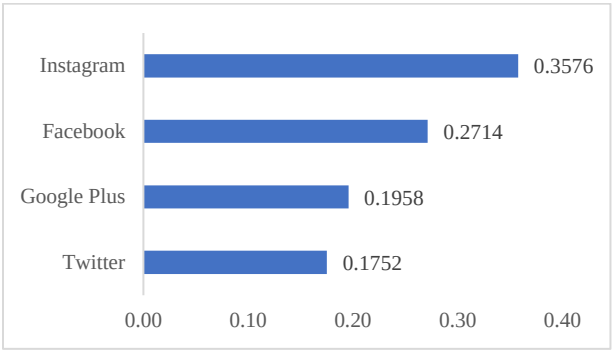

Figure 6. Preference of social networking site with respect to privacy.

Privacy is the only decision criterion which Facebook is not ranked as the first priority in the SNSs selection. Instagram is ranked as the top priority, followed by Facebook, Google Plus and Twitter. Instagram has advanced privacy settings as the users are allowed to manage those who are entitled to see and like the photos [52]. Therefore, it is a safe platform to share photos with a specific group of people.

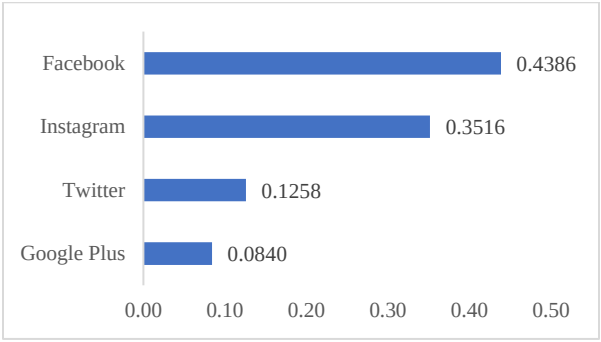

Figure 7. Preference of social networking site with respect to popularity.

In terms of popularity, Facebook has the highest priority among the SNSs, followed by Instagram, Twitter and Google Plus. According to DreamGROW [53], Facebook is ranked as the highest Top 15 Most Popular Social Networking Sites and Apps.

Equations (7) and (8) are used to identify the decision criterion's PIS and NIS, respectively. Figure 8 presents the decision criterion's PIS and NIS.

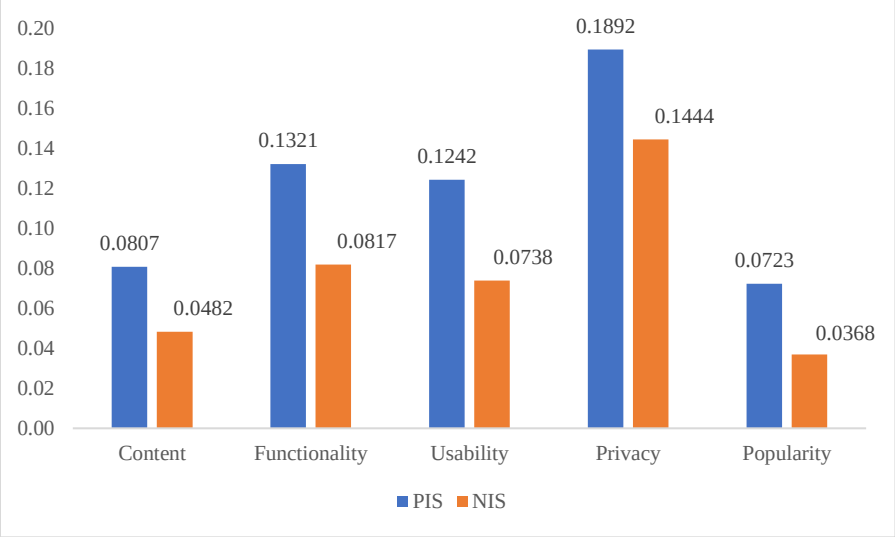

Figure 8. The decision criterion's PIS and NIS.

The PIS that identified by the AHP-TOPSIS model for content, functionality, usability, privacy and popularity are 0.0807, 0.1321, 0.1242, 0.1892 and 0.0723 respectively. The NIS that identified by the proposed AHP-TOPSIS model for content, functionality, usability, privacy and popularity are 0.0482, 0.0817, 0.0738, 0.1444 and 0.0368 respectively.

The decision alternatives' distance from PIS (S^+) and NIS (S^-) are determined by using (9) and (10) respectively. Figure 9 and Figure 10 show the decision alternatives' distance from PIS (S^+) and NIS (S^-) respectively.

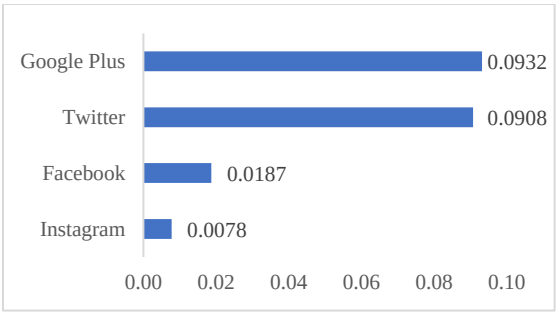

Figure 9. The decision alternatives' distance from PIS (S^+).

As shown in Figure 9, the distance of Google Plus to PIS is 0.0932, therefore Google Plus has the longest distance to the PIS compared to other SNSs. Twitter (0.0908) has the second farthest distance to the PIS, followed by Facebook (0.0187). In contrast, the distance of Instagram (0.0078) to PIS is the shortest. Thus, Instagram is very closed to the PIS as compared to other SNSs.

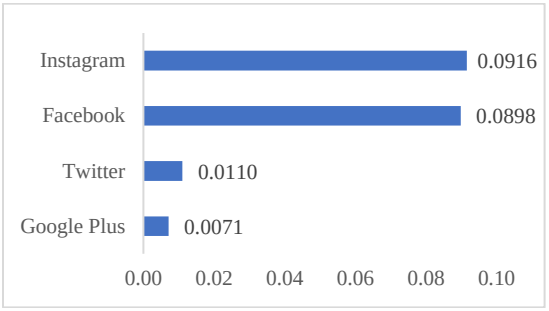

Figure 10. The decision alternatives' distance from NIS (S^-).

Based on Figure 10, the distance of Google Plus from NIS is 0.0071, therefore Google Plus has the shortest path to the NIS compared to other SNSs. Instagram (0.0916) has the longest path from the NIS, followed by Facebook (0.0898) and Twitter (0.0110).

The c_i of SNSs is presented in Figure 11.

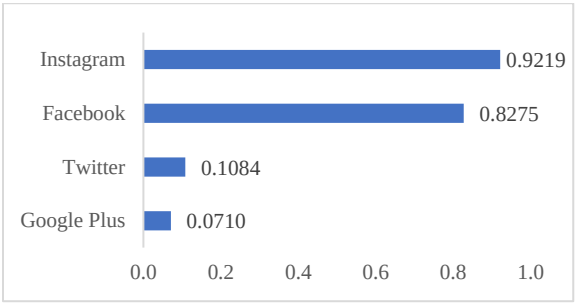

Figure 11. c_i of social networking sites.

As shown in Figure 11, the c_i for Instagram is 0.9219 which is the highest compared to other SNSs. Hence, Instagram is identified as the most popular SNS among the undergraduate students. On the other hand, the c_i for Facebook, Twitter and Google Plus are 0.8275, 0.1084 and 0.0710 respectively. This implies that the preference of the SNSs is followed by Facebook, Twitter and lastly Google Plus. Since Instagram and Facebook achieve the highest score of relative closeness coefficient, therefore it can be concluded that the popularity of the Instagram and Facebook is gaining much higher compared to Google Plus and Twitter.

4 CONCLUSION

The aim of this study is to determine the preferred social networking sites among Facebook, Twitter, Google Plus and Instagram, and identify the priority of decision criteria in the selection of social networking sites with the proposed AHP-TOPSIS model. Based on the results, privacy is the most influential decision criterion, followed by functionality, usability, content and lastly popularity. In addition, the undergraduate students are more likely to use Instagram and Facebook, followed by

Twitter and Google Plus. This research is quite significant as it can identify the most preferred SNS and the priority of the decision criteria in the selection of SNSs with the proposed AHP-TOPSIS model. In addition, this study can serve as reference to other less favourable SNSs such as Google Plus and Twitter to identify their potential improvements so that they can offer better services to their users in the future.

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REFERENCES

[1] T. P. Kiehne, "Social networking systems: History, critique, and knowledge management potentials," 2004. [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.119. 3436&rep=rep1&type=pdf

[2] C. Fuchs, "Social networking sites and complex technology assessment," *International Journal of E-Politics*, vol. 1, no. 3, pp. 19–38, 2010.

[3] P. I. Powale and G. D. Bhutkar, "Overview of privacy in social networking sites (SNS)," *International Journal of Computer Applications*, vol. 74, no. 19, pp. 39–46, 2013.

[4] C. M. Tang and M. H. Ngerng, "How do students select social networking sites? An Analytic Hierarchy Process (AHP) model," *International Journal of Cyber Society and Education*, vol. 8, no. 2, pp. 81–98, 2015.

[5] W. F. Lai and M. H. Ngerng, "Analysis of decision making on selection of the social networking sites by college students," *Pertanika Journal of Social Sciences & Humanities*, vol. 23, pp. 23–32, 2015.

[6] H. Waheed, M. Anjum, M. Rehman, and A. Khawaja, "Investigation of user behavior on social networking sites," *PLoS ONE*, vol. 12, no. 2, e0169693, 2017.

[7] T. A. Pempek, Y. A. Yermolayeva, and S. L. Calvert, "College students' social networking experiences on Facebook," *Journal of Applied Developmental Psychology*, vol. 30, no. 3, pp. 227–238, 2009.

[8] C. Lampe, N. Ellison, and C. Steinfield, "A Face (book) in the crowd: Social searching vs. social browsing", in *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*, 2006, pp. 167–170.

[9] F. Flavian, M. Guinaliu, and R. Gurrea, "The role played by perceived usability, satisfaction and consumer trust on website loyalty," *Information & Management*, vol. 43, no. 1, pp. 1–14, 2006.

[10] I. Ishak, F. Sidi, M. A. Jabar, N. F. M. Sani, A. Mustapha, and S. R. Supian, "A survey on security awareness among social networking users in Malaysia," *Australian Journal of Basic and Applied Sciences*, vol. 6, no. 12, pp. 23–29, 2012.

[11] Z. Katona, P. P. Zubcsek, and M. Sarvary, "Network effects and personal influences: The diffusion of an online social network," *Journal of Marketing Research*, vol. 48, no. 3, pp. 425–443, 2011.

[12] A. Hammouri, "An integrated AHP-TOPSIS methodology to evaluate for adoption cots database components based on usability," *Journal of Theoretical and Applied Information Technology*, vol. 96, no. 1, pp. 270–281, 2018.

[13] H. J. Mohammed, M. M. Kasim, and I. N. Shaharanee, "Evaluation of E-learning approaches using AHP-TOPSIS technique," *Journal of Telecommunication, Electronic and Computer Engineering*, vol. 10, no. 1-10, pp. 7–10, 2018.

[14] W. H. Lam, W. S. Lam, K. F. Liew, and S. C. Wong, "Data driven decision analysis on the selection of course programmes with AHP-TOPSIS model," *International Journal of Supply Chain Management*, vol. 7, no. 4, pp. 202–208, 2018.

[15] W. S. Lam, W. H. Lam, K. F. Liew, and J. W. Chen, "An empirical study on the preference of fast food restaurants in Malaysia with AHP-TOPSIS model," *Journal of Engineering and Applied Sciences*, vol. 13, no. 3, pp. 3226–3231, 2018.

[16] W. S. Lam, M. A. Bakar, W. H. Lam, and K. F. Liew, "Multi-criteria decision making in the selection of mobile network operators with AHP-TOPSIS model," *Journal of Engineering and Applied Sciences*, vol. 12, no. 23, pp. 6382–6386, 2017.

[17] M. Tyagi, P. Kumar, and D. Kumar, "Assessment of CSR based supply chain performance system using an integrated fuzzy AHP-TOPSIS approach," *International Journal of Logistics Research and Applications*, vol. 21, no. 4, pp. 378–406, 2018.

[18] K. F. Liew, W. S. Lam, and W. H. Lam, "An empirical evaluation on the efficiency of the companies in Malaysia with Data Envelopment Analysis model," *Advanced Science Letters*, vol. 23, no. 9, pp. 8264–8267, 2017.

[19] K. F. Liew, W. S. Lam, and W. H. Lam, "Financial analysis on the company performance in Malaysia with multi-criteria decision making model," *Systems Science and Applied Mathematics*, vol. 1, no. 1, pp. 1–7, 2016.

[20] W. S. Lam, K. F. Liew, and W. H. Lam, "Evaluation on the financial performance of the Malaysian banks with TOPSIS model," *American Journal of Service Science and Management*, vol. 4, no. 2, pp. 11–16, 2017.

[21] W. S. Lam, W. B. Leong, and W. H. Lam, "Selection of mobile network operator based on multi-criteria decision making model using Anaytic Hierarchy Process," *Mathematics and Statistics Journal*, vol. 1, no. 1, pp. 12–18, 2015.

[22] W. H. Lam, W. S. Lam, and K. F. Liew, "Improvement on the efficiency of technology companies in Malaysia with Data Envelopment Analysis model," *Lecture Notes in Computer Science*, vol. 10645, pp. 19–30, 2017.

[23] W. S. Lam, J. W. Chen, and W. H. Lam, "An empirical study on the selection of fast food restaurants among the undergraduates with AHP model," *American Journal of Information Science and Computer Engineering*, vol. 2, no. 3, pp. 15–21, 2016.

[24] W. S. Lam, W. H. Lam, S. H. Jaaman, and K. F. Liew, "Performance evaluation of construction companies using integrated Entropy-Fuzzy VIKOR model," *Entropy*, vol. 23, no. 3, pp. 320–335, 2021.

[25] W. S. Lam, W. H. Lam, K. F. Liew, M. A. Bakar, and J. X. Sim, "Analysis on the e-learning method in Malaysia with AHP-VIKOR model," *International Journal of Information and Education Technology*, vol. 11, no. 2, pp. 52–58, 2021.

[26] W. S. Lam and W. H. Lam, "Strategic decision making in portfolio management with goal programming model," *American Journal of Operations Management and Information Systems*, vol. 1, no. 1, pp. 34–38, 2016.

[27] W. S. Lam, R. S. Bishan, and W. H. Lam, "An empirical study on the mold machine-tool selection in semiconductor industry with Analytic Hierarchy Process model," *Advanced Science Letters*, vol. 23, no. 9, pp. 8286–8289, 2017.

[28] J. W. Chen, W. S. Lam, and W. H. Lam, "Optimization on the financial management of the bank in malaysia with goal programming model," *Journal of Fundamental and Applied Sciences*, vol. 9, no. 6S, pp. 442–451, 2017.

[29] W. S. Lam, S. H. Jaaman, and H. Ismail, "Portfolio optimization in enhanced index tracking with goal programming approach," *American Institute of Physics Conference Proceedings 1614*, 2014, pp. 968–972.

[30] W. S. Lam, W. H. Lam, and J. W. Chen, "Optimization on the bank financial management using two-stage goal programming model," *Lecture Notes in Electrical Engineering*, vol. 724, pp. 117–126, 2021.

[31] W. S. Lam, W. H. Lam, and K. F. Liew, "Data analysis on the performance of technology sector in Malaysia with Entropy-TOPSIS model," *Communications in Computers and Information Science*, vol. 886, pp. 194–203, 2018.

[32] W. S. Lam, K. F. Liew, and W. H. Lam, "Investigation on the performance of construction companies in Malaysia with Entropy-TOPSIS model," *Earth and Environmental Science*, vol. 385, no. 012006, pp. 1–7, 2019.

[33] J. W. Chen, W. S. Lam, and W. H. Lam, "Optimization and comparison of bank financial management in Malaysia with goal programming model," *Journal of Advanced Research in Dynamical and Control Systems*, vol. 11, no. 12S, pp. 39–46, 2019.

[34] A. J. X. Lai, W. H. Lam, and W. S. Lam, "Evaluation on the credit risk of companies in Malaysia with enhanced Data Envelopment Analysis model," *Journal of Advanced Research in Dynamical and Control Systems*, vol. 11, no. 12S, pp. 30–38, 2019.

[35] W. H. Lam, W. S. Lam, and K. F. Liew, "Optimization on the performance of technology companies in Malaysia with super-efficiency Data Envelopment Analysis model," *Journal of Advanced Research in Dynamical and Control Systems*, vol. 12, no. 4S, pp. 1424–1433, 2020.

[36] T. L. Saaty, "The Analytic Hierarchy Process," New York: McGraw-Hill, 1980.

[37] W. S. Lam, M. A. Bakar, W. H. Lam, J. W. Chen, and H. L. Ma, "Evaluation on the preference of coffee shops among undergraduate students with Analytic Hierarchy Process model," *International Journal of Supply Chain Management*, vol. 7, no. 4, pp. 209–215, 2018.

[38] W. S. Lam, R. S. Bishan, W. H. Lam, and K. F. Liew, "An empirical evaluation on the preference of supermarkets with Analytic Hierarchy Process model," *Journal of Physics: Conference Series*, vol. 995, no. 012037, pp. 1–9, 2018.

[39] T. L. Saaty, "Decision making with the Analytic Hierarchy Process," *International Journal of Services Sciences*, vol. 1, no. 1, pp. 83–98, 2008.

[40] W. S. Lam, W. K. Lee, and W. H. Lam, "Multi-criteria decision making in job selection problem using Analytic Hierarchy Process model," *Mathematics and Statistics Journal*, vol. 1, no. 2, pp. 3–7, 2015.

[41] W. L. Winston, "Operations Research and Algorithms," Belmont: Brooks/Cole, 2004.

[42] E. A. Esan, N. Nordin, and W. N. W. M. Radzi, "A study of customer-based brand equity prioritization by using Analytical Hierarchy Process," *Applied Mathematics and Computational Intelligence*, vol. 7, no. 1, pp. 23–32, 2018.

[43] N. I. Idrus, W. N. W. M. Radzi, and N. Nordin, "An investigation of the weighted measurement for charity services by using Analytical Hierarchy Process," *Applied Mathematics and Computational Intelligence*, vol. 7, no. 1, pp. 39–46, 2018.

[44] W. L. Winston and J. B. Goldberg, "Operations Research: Applications and Algorithms," 4th Edn. Brooks/Cole USA, 2004, pp. 1418.

[45] W. S. Lam, K. F. Liew, and W. H. Lam, "An optimal control on the efficiency of technology companies in Malaysia with Data Envelopment Analysis model," *Journal of Telecommunication, Electronic and Computer Engineering*, vol. 10, no. 1, pp. 107–111, 2018.

[46] W. S. Lam, K. F. Liew, and W. H. Lam, "Investigation on the efficiency of financial companies in Malaysia with Data Envelopment Analysis model," *Journal of Physics: Conference Series*, vol. 995, no. 012021, pp. 1–10, 2018.

[47] W. S. Lam, J. W. Chen, and W. H. Lam, "Data driven decision analysis in bank financial management with goal programming model," *Lecture Notes in Computer Science*, vol. 10645, pp. 681–689, 2017.

[48] C. L. Hwang and Yoon, "Multi-attribute decision making," Berlin: Springer-Verlag, 1981.

[49] W. H. Lam, M. A. Din, W. S. Lam, and J. W. Chen, "Evaluation on the performance of suppliers in Malaysia with TOPSIS model," *Journal of Fundamental and Applied Sciences*, vol. 10, no. 6S, pp. 406–415, 2018.

[50] W. H. Lam, W. S. Lam, and K. F. Liew, "Performance analysis on telecommunication companies in Malaysia with TOPSIS model," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 13, no. 2, pp. 744–751, 2019.

[51] V. S. Rao, "10 reasons: Why is Facebook so popular and successful?," 2015. [Online]. Available: https://www.technotification.com/2015/01/why-facebook-is-so-popular.html

[52] TechOpti, "Why Instagram is better than Facebook," 2013. [Online]. Available: https://www.techopti.com/why-instagram-is-better-than-facebook/

[53] DreamGROW, "Top 15 most popular social networking sites and apps," August 2018. [Online]. Available: https://www.dreamgrow.com/top-15-most-popular-social-networking-sites/