Influencing Factors for Internet Banking Adoption using Analytical Hierarchy Process (AHP) Approach

Khairi Azhar Aziz\textsuperscript{1}, Marzanah A. Jabar\textsuperscript{2}, Salfarina Abdullah\textsuperscript{3}, Rozi Nor Haizan Nor\textsuperscript{4}, Nur Ilyana Ismarau Tajuddin\textsuperscript{5}

\textsuperscript{1,2,3,4}Department of Software Engineering and Information System, Faculty of Computer Science and Information Technology, Universiti Putra Malaysia
\textsuperscript{5}UCSI University

\textsuperscript{1}hairie_azdhar@yahoo.com, \textsuperscript{2}marzanah@upm.edu.my, \textsuperscript{3}salfarina@upm.edu.my, \textsuperscript{4}rozinor@upm.edu.my, \textsuperscript{5}nurilyana@ucsiuniversity.edu.my

\textbf{Article History:} Received: 10 November 2020; Revised: 12 January 2021; Accepted: 27 January 2021; Published online: 05 April 2021

\textbf{Abstract:} Internet banking is an online financial transaction approach that uses internet as the platform. Customers could perform their transactions anywhere and anytime. Current extensive researches from the literature have analyzed and investigated on various factors related to the internet banking adoption. Drawing from the various theories associated with acceptance model, this paper will combine these various predetermined factors into one model. Analytical Hierarchy Process (AHP), method was adapted in identifying the relevant multiple factors for the model. AHP is the best technique to use for mathematical calculation, to allow decision makers to prioritize their ranking to fit and resolve multiple criteria. The purpose of this paper is to prioritize the influencing factors to use internet banking. Based on the literature review, three main factors namely technical information, website and service availability had been identified as the main construct of the model and the sub factors were communication, responsiveness, privacy, ease of use, security, reliability and efficiency had been proposed into one integrated framework. These factors were identified by using Systematic Literature Review (SLR) methodology. Hence, the paper will deepen the understanding of the specific factors underpinned in the study of internet banking adoption.

\textbf{Keywords:} Analytic hierarchy process (AHP); Internet banking adoption; Internet banking success factors; influencing factor of Internet banking

1. Introduction

Internet banking adoption that allow customers to making a financial transaction at anytime and anywhere to fulfill their daily routines. The Internet has been the source for the users to search and query for things they want to buy, travel, socialize, banking and financing as well as finding reading materials (Saad et al., 2014; 2016; Alwan et al., 2016). Internet banking becomes popular among customers such as public, private, corporation, senior citizen or student to their satisfaction. Instead through over the counter, time constraint urges customers to using internet banking to get the fast services to fulfill their commitment. According to Sundara and Perera (2018), customers essentially use internet banking for bill payment, funds transfer and loan payment.

Basically, internet banking satisfaction will impact the quality of service (Sundara and Perera, 2018). In fact, any changes in internet banking service will reflect the customer’s satisfaction. Customers will be unsatisfied and frustrated if their needs failed to meet their satisfaction. The service quality could provide the best factors to get customers experience, excellence, valuable and suitability to use. According to Yarimoglu (2014), the service quality will determine how much service to delivered to the customers and meet their expectation. With the best of service quality, customers will accept the service and proposed ideas and product.

Besides, according to Robles and Ospino (2017), technical information factor was implemented and establish scope by the following sub factors such as efficiency and reliability (Eri et al., 2012; Jabar et al., 2014; Hussain et al., 2015; Gheni et al., 2016). Skvarciany (2018) also found that website factor is the strongest dimension will affect positively to adopt internet banking by customer. By analyzing the website factor, the sub factors as security, ease of use and privacy were found to increase the customer adoption (Iskandar Ishak et al., 2012; Sidi et al. 2013). Hammoud et al. (2018), revealed that service availability factor also impacts to the level of adoption with the sub factors such as communication and responsiveness. These sub factors were contributing to the adoption despite in the average stages. The motivation of this paper is to investigate further on these factors and to prioritize the influencing factors of internet banking adoption.

2. Objective

The objectives of this paper are to prioritize influencing factors of internet banking adoption among customer.
3. Methodology

The decision is referring to the choice made through various existing alternatives. Choice of factors is a function of the decision maker's objective, so in the alternative assessment to be selected, the creator is also keen to know the consequences of the action, as opposed to the choice made. The choice was involving the element of uncertainty. Making of decision is defined as the process to evaluate the best factors among the best that are available (Hossain et al., 2014; Ektefa et al., 2011a; Ektefa et al., 2011b; Jauhar et al., 2015; Sidi et al., 2018). According to Zavadskas et al. (2016), decision making also could be used to improve the organizations by sustainability of industries.

Multi Criteria Decision-Making (MCDM) was referring to multiple factors to be selected based on the best of factors availability. Hence, few theories and methods had been developed to improve MCDM such as AHP as recommended by Saaty (1980). Zavadskas and Govindan et al. (2016), revealed that AHP method is the most frequent methods for MCDM especially in industries related to banking, construction and engineering. Hence, this paper aims to resolve the decision making using AHP method which is to prioritize the factors determined.

Yaghubi and Seyedin (2015), found that AHP consists of a few processes such as to decompose the issues into hierarchical structures that contain the purpose, factor, alternatives, criteria and the sub-criteria. This hierarchical structure of internet banking adoption takes a few steps. The level one (Level 1: Goal) is to set the goal for the research. The level two (Level 2: Criteria) is to identify the criteria or factors such as technical information by Robles and Ospino (2017) and Jamil et al., (2015), website by Skvarciany (2018) and service availability by Hammoud et al. (2018) which have a significant adoption to induce the best factors for internet banking. The last level which is (Level 3: Sub-criteria) is to extract the comparison of pairwise to the overall goal. The authors choose these levels of hierarchical is solitary to elucidate the AHP concept. Previous papers do not measure by AHP method to their research. Hence, in this paper, the authors are being explained pertaining factors to prioritize using AHP method. These seven criteria were chosen based on the extensive literature review and discussion with expert from decision group. Figure 1 shows how AHP reflect to the issues.

![Hierarchical tree of AHP process](image)

Due to the measuring of impact criteria to the level one which is a goal, the comparison of pairwise is importance to the design of AHP. Generally, the steps show that the comparison of fair between criteria and research objective. Therefore, the mechanism is to extract a testing for consistency of the main factors. The process step of enhancement to pairwise between criteria and goal. Besides, to make a value of comparison of pairwise, the respective of priority of each criteria with other using the matrix of pairwise. Table 1 shows that the scale and important of value attributes to the each of number by Saaty (2012).
By using this AHP technique, this research will attempt to show the internet banking adoption to be rank based on the identified factors. This technique can be applied in banking environment to evaluating their service quality and the same time to identify which of service quality requires most efforts and impact to the services and fulfill customer satisfaction, Haery et al. (2014). AHP also allow the quantitative and qualitative to the similar of decision-making technique, which is by giving an eliciting, recording, discussing and evaluate elements for a decision, Miran (2017). Therefore, this decision support technique could be applied and used to resolve a complex of decision issues. According to Zuraidi et al. (2018), to resolve multi factors in internet banking adoption, the AHP is the best approach and reasonable to use to select the appropriate factors element. The superiority of decision support method was based on paired pair rating of factors validated by the experts. Furthermore, AHP concept was used due to the understandable, rationalistic and the simple calculation process.

4. Result and Discussion

Based on the AHP approach, below is the result of internet banking adoption populate from Figure 1 using AHP method approach. This scale to determine by the Saaty (2012) for pairwise comparison scale (refer table 1). The scale to determine which factors are importance and more impacted to the decision making. Table 2 revealed the contrast of pairwise for main criteria with an overall goal. From that, the highest total was performed by service availability with matrix value of 6.0. this reveals that the service availability has a significant influencing to the goal. The technical information with matrix value 4 and website with matrix value 1.75.

Table 1. Importance of score variable

| Verbal judgment          | Numeric value |
|--------------------------|---------------|
| Extremely important      | 9             |
| Very strong more important | 7             |
| Strong more important     | 5             |
| Moderately more important | 3             |
| Equally important        | 1             |

Table 2. Comparison of pairwise for the criteria

| Goal                      | Technical information | Website | Service availability |
|---------------------------|-----------------------|---------|----------------------|
| Technical information     | 1                     | 2/4     | 1                    |
| Website                   | 2                     | 1       | 4                    |
| Service availability      | 1                     | 1/3     | 1                    |
| Total                     | 4                     | 1.75    | 6.0                  |

Besides, the next phase is paired comparison between sub-criteria on the same level. The comparison as per table 3, 4 and 5. Based on the table 3, reliability is the highest matrix value among the technical information sub-criteria with a matrix value of 2.50 and efficiency with a matrix value of 1.67.

Table 3. Comparison of pairwise for the technical information sub-criteria

| Goal             | Efficiency | Reliability |
|------------------|------------|-------------|
| Efficiency       | 1          | 3/2         |
| Reliability      | 0.67       | 1           |
| Total            | 1.67       | 2.50        |

Based on the table 4, privacy is the highest matrix value among the website sub-criteria with a matrix value of 5.00 following by ease of use with a matrix value of 4.50 and security with a matrix value of 1.83.

Table 4. Comparison of pairwise for the website sub-criteria

| Goal        | Security | Ease of use | Privacy |
|-------------|----------|-------------|---------|
| Security    | 1        | 3           | 2       |
Based on the table 5, responsiveness is the highest matrix value among the service availability sub-criteria with a matrix value of 4.03 and communication with a matrix value of 1.33.

| Goal             | Responsiveness | Communication |
|------------------|----------------|---------------|
| Responsiveness   | 1/3            | 1/3           |
| Communication    | 3.03           | 1             |
| Total            | 4.03           | 1.33          |

Table 6 and 7 shows the CR (Consistency Ratio) of the CI (Consistency Index) to the random index (CI) for level 2 criteria (technical information, website and service availability). It is show that the result for CI is 0.025 and CR is 0.04.

| Goal           | Technical information | Website | Service availability | Priority |
|----------------|-----------------------|---------|----------------------|----------|
| Technical info | 0.25                  | 0.27    | 0.17                 | 23.41%   |
| Website        | 0.50                  | 0.55    | 0.67                 | 57.94%   |
| Service avail  | 0.25                  | 0.18    | 0.17                 | 18.65%   |
| Total          | 100%                  |         |                      |          |

Table 7. \( \lambda_{max} \) calculation

| Weighted-Sum (WS) | Priority (P) | WS/P | CI = (\( \lambda_{max} – n \)) / (n–1) | CR = CI / RI |
|-------------------|--------------|------|--------------------------------------|--------------|
| 0.73              | 0.2341       | 3.0338983 | = (3.05 – 3) / (3 – 1) | = 0.025 / 0.66 |
| 1.75              | 0.5794       | 3.0958904 | = (0.05) / (2) | = 0.04 |
| 0.63              | 0.1865       | 3.0319149 | = 0.025 | = 0.04 |

Table 8 and 9 shows the CR (Consistency Ratio) of the CI (Consistency Index) to the random index (CI) for level 3 sub-criteria (efficiency and reliability). It is show that the result for CI and CR are 0.

| Goal           | Efficiency | Reliability | Priority |
|----------------|------------|-------------|----------|
| Efficiency     | 0.60       | 0.60        | 60%      |
| Reliability    | 0.40       | 0.40        | 40%      |
| Total          | 100%       |             |          |

Table 9. Calculation of \( \lambda_{max} \) for the technical information sub-criteria

| Weighted-Sum (WS) | Priority (P) | WS/P | CI = (\( \lambda_{max} – n \)) / (n–1) | CR = CI / RI |
|-------------------|--------------|------|--------------------------------------|--------------|
| 0.93              | 0.6          | 2    | = (2 – 2) / (2 – 1) | = 0 / 0.66 |
| 1.07              | 0.4          | 2    | = (0) / (1) | = 0 |

Table 10 and 11 shows the CR (Consistency Ratio) of the CI (Consistency Index) to the random index (CI) for level 3 sub-criteria (website). It is show that the result for CI is 0.07 and CR is 0.10.

| Goal           | Security | Ease of use | Privacy | Priority |
|----------------|----------|-------------|---------|----------|
| Security       | 0.55     | 0.67        | 0.4     | 53.74%   |
| Ease of use    | 0.18     | 0.22        | 0.4     | 26.80%   |
Influencing Factors for Internet Banking Adoption using Analytical Hierarchy Process (AHP) Approach

Privacy 0.27 0.11 0.2 19.46% 100%

Table 11. Calculation of λmax for the website sub-criteria

| Weighted-Sum (WS) | Priority (P) | WS/P | CI = (λmax – n) / (n–1) | CR = CI / RI |
|-------------------|--------------|------|--------------------------|--------------|
| 1.46              | 0.5374       | 3.2205514 | (3.13 – 3) / (3 – 1)   | 0.07 / 0.7   |
| 0.88              | 0.2680       | 3.120603  | (0.13) / (2)            | 0.10         |
| 0.65              | 0.1946       | 3.0692042 | 0.07                     |              |

Table 12 and 13 shows the CR (Consistency Ratio) of the CI (Consistency Index) to the random index (CI) for level 3 sub-criteria (service availability). It is show that the result for CI and CR are 0.

According to Brunelli (2015), the judgments to acceptable with reasonably consistent if CR shows that less than 0.10. If the CR shows more than 0.10, it is required to revise and correct it. Hence, this paper proves that AHP shows an effectiveness and relevancy of priorities approach to be apply in the model or framework.

Table 12. Normalized matrix comparison of pairwise for the service availability sub-criteria

| Goal              | Responsiveness | Communication | Priority |
|-------------------|----------------|---------------|----------|
| Responsiveness    | 0.25           | 0.25          | 24.81%   |
| Communication     | 0.75           | 0.75          | 75.19%   |

= 100%

Table 13. Calculation of λmax for the service availability sub-criteria

| Weighted-Sum (WS) | Priority (P) | WS/P | CI = (λmax – n) / (n–1) | CR = CI / RI |
|-------------------|--------------|------|--------------------------|--------------|
| 0.65              | 0.2481       | 2    | (2 – 2) / (2 – 1)        | 0 / 0.66     |
| 1.35              | 0.7519       | 2    | (2) / (1)                | 0            |

= 0

Table 14 shows that factors based on the ranking. Ease of use factor has the highest impact weight value is 24.83% among the comparison factors. The second highest is security with weight value is 22.08% and the lowest factor is communication with weight value is 4.67%. This reveals that the ease of use factor is the most of preferred choice to influence of internet banking adoption.

Table 14. Factors based on the ranking

| Criteria             | Factors     | Weight (%) | Ranking |
|----------------------|-------------|------------|---------|
| Technical information (23.41%) | Efficiency | 7.8        | 6       |
|                      | Reliability | 15.6       | 3       |
| Website (57.94%)     | Security    | 22.08      | 2       |
|                      | Ease of use | 24.83      | 1       |
|                      | Privacy     | 11.03      | 5       |
| Service availability (18.65%) | Responsiveness | 13.99     | 4       |
|                      | Communication | 4.67       | 7       |

5. Future Work and Conclusion

These paper shows the strength of AHP method of multiple criteria to evaluate factors influencing internet banking adoption. By using the combination of three levels of concept, this paper has successfully access for priority of ranking. It is hoped that the new researchers would be able to enhance and extend the AHP method to be more efficient and reliable in resolving problems in internet banking adoption and assessment. The discussed method was illustrating their capacity for decision-making in determining and performing assessment for the best factors. The methods are deemed suitable for organizational decision-making. In this paper, factors are identified by using this mechanism method. According to researchers Wang et al. (2018), have proven and parallel that AHP
could assist the decision-makers to assemble decisions to resolve the multi-conflicting factors. As we know, the AHP method is to resolve multi-criteria for complex decision problems by prioritized rankings. Besides, to rank the factors, the combination of method could be considered or hybrid technique can be adapted for the future research and the study should cover including Sabah and Sarawak, instead of only focuses on Klang Valley, Selangor and Kuala Lumpur.

6. Acknowledgements

The authors would like to express gratitude for the financial support provided under the Fundamental Research Grant Scheme (FRGS) Grant Cost Centre: 5540287.

References

1. Alwan, A. A., Ibrahim, H., Udzir, N. I., & Sidi, F. (2016). An efficient approach for processing skyline queries in incomplete multidimensional database. Arabian Journal for Science and Engineering, 41(8), 2927-2943. doi:10.1007/s13369-016-2048-z.
2. Alwan, A. A., Ibrahim, H., Udzir, N. I., & Sidi, F. (2017). Processing skyline queries in incomplete distributed databases. Journal of Intelligent Information Systems, 48(2), 399-420. doi:10.1007/s10844-016-0419-2.
3. Brunelli, M. 2015. Introduction to the analytic hierarchy process. Springer Briefs in Operations Research. https://doi.org/10.1007/B978-0-12-416727-8.00003-5.
4. 2016. Hybrid multiple criteria decision-making methods: A review of applications for sustainability issues. Economic ResEaRch-Ekonomska IstRaživanja, 29(1), 857– 887. https://doi.org/10.1080/1331677X.2016.1237302.
5. Ektefa, M., Jabar, M. A., Sidi, F., Memar, S., Ibrahim, H., & Ramli, A. 2011a. A threshold-based similarity measure for duplicate detection. IEEE Conference on Open Systems, ICOS 2011, 37-41. doi:10.1109/ICOS.2011.6079233.
6. Ektefa, M., Sidi, F., Ibrahim, H., Jabar, M. A., & Memar, S. 2011b. A comparative study in classification techniques for unsupervised record linkage model. Journal of Computer Science, 7(3), 341-347. doi:10.3844/jcssp.2011.341.347.
7. Erī, Z. D., Abdullah, R., Jabar, M. A., & Murad, M. A. A. (2012). Virtual communities model using ontology of group classification for research communities. International Conference on Information Retrieval and Knowledge Management, CAMP’12, 126-130. doi:10.1109/InfRKM.2012.6205019
8. Gheni, A. Y., Jusoh, Y. Y., Jabar, M. A., & Ali, N. M. (2016). Factors affecting global virtual teams’ performance in software projects. Journal of Theoretical and Applied Information Technology, 92(1), 90-97
9. Haery, F. A., Ghorbani, H., & Farahmand, A. A. 2014. An AHP approach for ranking critical success factors of customers experience in Iranian banks from managers’ viewpoint. International Journal of Marketing Studies, 6(1), 168–176. https://doi.org/10.5539/ijms.v6n1p168.
10. Hammoud, J., Bizri, R. M., & El Baba, I. 2018. The impact of e-banking service quality on customer satisfaction Evidence from the Lebanese banking sector. SAGE Open, 8(3). https://doi.org/10.1177/2158244018790633
11. Hossain, J., Sani, N. F. M., Affendey, L. S., Ishak, I., & Kasimiran, K. A. 2014. Semantic schema matching approaches: A review. Journal of Theoretical and Applied Information Technology, 62(1), 139-147.
12. Hussain, A., Abubakar, H.I., Hashim, N.B. (2015). Evaluating mobile banking application: Usability dimensions and measurements. Conference Proceedings - 6th International Conference on Information Technology and Multimedia at UNITEN. ICIMU 2014, art. no. 7066618, pp. 136-140.
13. Iskandar Ishak, Sidi, F., Jabar, M. A., Sani, N. F. M., Mustapha, A., Supian, S. R., & Apau, M. N. (2012). A survey on security awareness among social networking users in malaysia. Australian Journal of Basic and Applied Sciences, 6(12), 23-29
14. Jabar, M. A., Khalefa, M. S., Abdullah, R. H., & Abdullah, S. 2014. Meta-analysis of ontology software development process. International Review on Computers and Software, 9(1), 29-37.
15. Jamil, N. B. C. E., Ishak, I. B., Sidi, F., Affendey, L. S., & Mamat, A. (2015). A systematic review on the profiling of digital news portal for big data veracity. Paper presented at the Procedia Computer Science, , 72 390-397. doi:10.1016/j.procs.2015.12.154
16. Jauhar, J., Ghani, A.B.A., Joarder, M.H.R., Subhan, M., Islam, R. (2015). Brain drain to Singapore: A conceptual framework of Malaysians' diaspora. Social Sciences (Pakistan), 10 (6),
Influencing Factors for Internet Banking Adoption using Analytical Hierarchy Process (AHP) Approach

pp. 702-711.

17. Miran, I. H. 2017. A mixed methods approach to investigate the electronic banking websites service quality: The case of Egypt. Arab Academy for Science, Technology and Maritime Transport Advanced Management Institute Cardiff Metropolitan University. *Academy for Science, Technology and Maritime Transport Advanced Management Institute Cardiff Metropolitan University*.

18. Robles, C., & Ospino, A. 2017. An analytic hierarchy process-based approach for evaluating renewable energy an analytic hierarchy process-based approach for evaluating renewable energy sources, (October).

19. Saad, N. H. M., Ibrahim, H., Alwan, A. A., Sidi, F., & Yaakob, R. (2014). A framework for evaluating skyline query over uncertain autonomous databases. Procedia Computer Science, 29 1546-1556. doi:10.1016/j.procs.2014.05.140.

20. Saad, N. H. M., Ibrahim, H., Sidi, F., Yaakob, R., & Alwan, A. A. (2016). Computing range skyline query on uncertain dimension, doi:10.1007/978-3-319-44406-2_31.

21. Sidi, F., Ishak, I., & Jabar, M. A. 2018. Malayik: An ontological approach to knowledge transformation in malay unstructured documents. International Journal of Electrical and Computer Engineering, 8(1), 1-10. doi:10.11591/ijece.v8i1.pp1-10.

22. Sidi, F., Jabar, M.A., Mustapha, A., Sani, N.F., Ishak, I., & Supian, S.R. (2013). Measuring computer security awareness on internet banking and shopping for internet users. Journal of Theoretical and Applied Information Technology, 53(2): 210-216.

23. Skvarciany, V., & Jurevičiene, D. 2018. Factors influencing individual customers trust in internet banking: Case of Baltic states. *Sustainability (Switzerland)*, 10(12). https://doi.org/10.3390/su10124809.

24. Wang, S., Sheng, Z., Xi, Y., Ma, X., Zhang, H., Kang, M., … Han, Z. 2018. The application of the analytic hierarchy process and a new correlation algorithm to urban construction and supervision using multi-source government data in Tianjin. *ISPRS International Journal of Geo-Information*, 7(2), 50. https://doi.org/10.3390/ijgi7020050

25. Zavadskas, E. K., Govindan, K., Antucheviciene, J., & Turskis, Z. 2016. Hybrid multiple criteria decision-making methods A review of applications for sustainability issues. *Economic Research-Ekonomska Istraživanja*, 29(1), 1–31. https://doi.org/10.1080/1331677X.2016.1237302.

26. Zavadskas, E. K., Govindan, K., Antucheviciene, J., Turskis, Z., & Kazimieras Zavadskas,

27. Zuraidi, S. N. F., Rahman, M. A. A., & Akasah, Z. A. 2018. A study of using AHP method to evaluate the criteria and attribute of defects in heritage building. *E3S Web of Conferences*, 65, 01002. https://doi.org/10.1051/e3sconf/20186501002.