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How analytical hierarchy process prioritizing internet banking influencing factors? a research study

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ABSTRACT

Internet banking is a method for conducting financial transactions online that makes use of the internet as a platform. Customers could transact at any time and from any location. Numerous aspects relating to the adoption of internet banking have been analyzed and studied in recent in-depth studies from the literature. This paper will merge these numerous predefined factors into a model by drawing on the various ideas related to the acceptance model. It was decided to adapt the analytical hierarchy process (AHP) method for finding the important numerous components for the model. The finest mathematical calculation method is AHP, which enables decision-makers to prioritize their ranking in order to satisfy various criteria. The goal of this research is to rank the elements that influence the use of online banking. Three main factors such as technical information, website and service availability were chosen as the main factors of the model based on the literature review. Sub-factors such as ease of use, responsiveness, privacy, reliability, security, communication and efficiency were also suggested and combined into a single integrated framework. Utilizing the systematic literature review (SLR) methodology, several factors were found. As a result, the article will enhance understanding of the unique elements supporting the adoption of internet banking.

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1. INTRODUCTION

Adoption of internet banking, which enables users to conduct financial transactions whenever and wherever they like to complete daily tasks. Customers including public, private, corporate, senior citizens, and students find internet banking to be popular. Time constraints force customers to use internet banking in place of over-the-counter services in order to obtain quick services in order to achieve their obligation. Customers primarily use internet banking for loan repayment, money transfers, and bill payment, according to [1]. In essence, customer happiness with online banking will influence the level of service [1]. In reality, any modifications to the internet banking service will take user pleasure into account. If the needs of the customer are not met, they will be disappointed and frustrated. The best elements to get a positive client experience, excellence, value, and suitability for usage, could be provided by the service quality. According to [2], the level of service that is provided to clients will depend on how well their expectations are met.

Customers will accept the service, presented ideas, and product with the finest service quality. Additionally, according to [3], the technical information factor was applied and its scope was established by the following subfactors, including efficiency and reliability. Skvarciany and Jurevičienė [4] also discovered that the website aspect is the strongest variable that will favorably effect a customer's adoption of internet banking. Security, ease of use, and privacy were discovered to boost consumer adoption through an analysis of the Website factor. According to [5] showed that the subfactors of communication and responsiveness together with the service availability factor had an impact on the adoption level. Even though they were in their infancy, these little influences were influencing adoption. The goal of this article is to priorities the elements that influence the adoption of internet banking and to look at these aspects in more detail. By creating a decision support system that can analyze methodically and consistently to generate an acceptable and accurate conclusion, the research seeks to address this [6]. The decision levels in analytical hierarchy process (AHP) preserve a unidirectional hierarchical relationship. AHP is a simpler and more successful method of handling both qualitative and quantitative data in multi-criteria decision-making (MCDM) [7]. AHP breaks down complicated problems from higher hierarchies to lower hierarchies, integrating expert opinions and assessment scores into a straightforward elementary hierarchy structure [8]. However, the goals of this article are to look into, analyses, and rank the elements that influence consumer adoption of internet banking. The AHP technique was applied to this work as a consequence, producing the desired result. Making decisions is an activity with a major impact on how well a corporation performs. Decisions are everywhere and have an impact on many facets of our lives. Making decisions is a skill that people use throughout their life because it is a trait of the human species [9]. AHP is a thorough approach that can address complicated decision-making issues by organizing the issue, quantifying its elements, and weighing potential solutions using decision hierarchies. It is theoretically simple to understand, simple to put into practice, and its outcomes are simple for specialists in other fields to interpret [10]. It is theoretically simple to understand, simple to put into practice, and its outcomes are simple for specialists in other fields to interpret [11]. Making decisions is a constant in the industry. As a result, the manager frequently needs to make judgements quickly, even in a chaotic workplace. The "Garbage can model of organizational choice" has been used to describe decision-making in similar circumstances [12]. The decision-making procedure is shown in Figure 1.

A set of objects, a set of numbers, and a mapping of objects to numbers are further components of the AHP measurement scale [13]. The steps are categorizing the issue to create a hierarchy, gathering data through pairwise comparison, setting priorities, and conducting analysis to find a solution [14]. The range of alternatives and criteria are compared by the decision-makers as they assess their options. In general, relative criteria are of various kinds. Multi-criteria analysis has a basic issue with going back to a single unit. The usage of comparison expressions' quantitative "equivalents" is essential. Their evaluations are based on a rating scale created by [14], which offers a way to numerically indicate the relative importance of the components. Pairwise comparison is the main obstacle for AHP. The pairwise comparison takes into consideration the following issues: i) each sub criteria must be taken into account for each option; ii) each sub criteria must be taken into account for the major criterion; and iii) the aim must be taken into account for each of the main criterion [15]. Using the sorting of numbers to properly mix the priorities that come from them, AHP aims a rigorous implementation of the scaling problem in this context [13]. Figure 2 shows the decision-making process.

The AHP does not demand that choices be consistent or transitive but instead offers a comprehensive framework to deal with intuitive, rational, and irrational judgements concurrently [16]. Overcoming the limitations of traditional AHP, this method methodically formulates specialists' knowledge of equipment while effectively allocating the resources that are available [17]. AHP is more suited for determining weight coefficients because it allows decision-makers to better comprehend the relative value of interacting alternatives and criteria [11]. The AHP includes beliefs and methods for prioritizing among the criteria and sub-criteria, leading to different conclusions [18]. Comparing Saaty's AHP to earlier decision support techniques, its simplicity is one of its key advantages. Goals, secondary goals or components, and options are used in a hierarchical manner. By providing a foundation for eliciting, discussing, documenting, and assessing the components of a choice, it also facilitates the integration of qualitative and quantitative into the same decision-making technique. Better information management has been seen in the banking sector as being crucial to guaranteeing the security of all financial transactions [19].

A quantitative examination of a qualitative problem is done using the AHP technique, which has the advantages of being straightforward, adaptable, and useful. AHP technique may more effectively address the problem of human resources management strategy optimization in the internet of things industry [20]. It has two sections, a trim level and a streamline, and is distinguished by the complexity of its many diverse characteristics. The advantage of this decision-support tool is that the user's choices and criteria are rated in pairs to establish the final position. Additionally, the AHP approach is employed since the computation procedure is straightforward and the logic is logical and understandable [21]. AHP is attractive to a wide range of MCDM challenges due to its capacity to cope with the expert's subjective judgements and produce a

quantitative priority vector that defines each alternative's relative relevance [22]. The AHP approach is a procedure that aids decision-makers in discovering the best option rather than a model for determining the correct response. The value of this methodology for organizations and academic research has been established. Organizations can prospect their own tactics and those of their rivals with the use of the AHP approach [23].

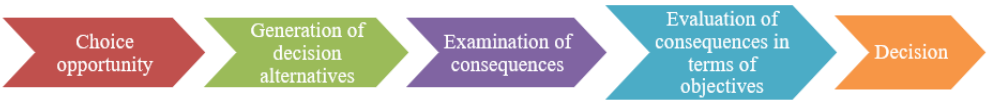

Figure 1. Schematic representation of the decision-making process

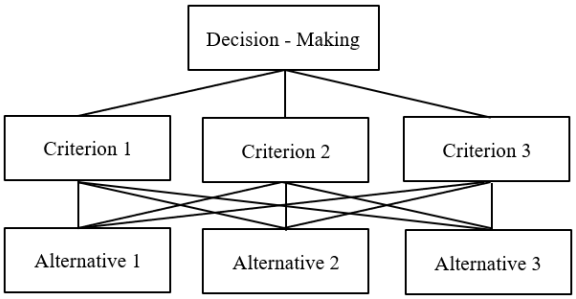

Figure 2. Decision-making based AHP method

2. METHOD

The decision is the one chosen after carefully weighing all of the alternatives. Since the aim of the decision maker influences the choice of components, the creator is also interested in learning the outcomes of the activity rather than the option chosen when making an alternative assessment. There was some degree of doubt in the choice. Decision-making is the process of choosing the best components from the finest possibilities available. Decision-making can also be utilized to improve companies through industrial sustainability, claims [24]. MCDM refers to the process of selecting multiple variables based on the best available aspects. Due to this, very few theories and methods, such as AHP as recommended by [13], have been developed to enhance MCDM. The AHP approach is the most widely used MCDM technique, according to [24], especially in the banking, construction, and engineering industries. This work's objective is to resolve decision-making using the AHP approach, which involves giving the recognized elements a priority. The processes utilized in AHP involve breaking down problems into hierarchical structures that comprise the purpose, factor, choices, criteria, and sub-criteria, according to researchers [25]. The adoption of internet banking is done in a step-by-step, hierarchical manner. Level 1 (level 1: goal) is all on defining the research's objective. The second level (level 2: criteria) outlines the standards or elements that are widely used to provide the ideal conditions for online banking, such as the technical information provided by [3], the website provided by [4], and the availability of services provided by [5]. The final step, step 3: sub-criteria, involves extracting pairwise comparisons to the ultimate objective. To clarify the AHP concept, the authors chose these levels of hierarchical isolation. Previous studies did not measure their research using the AHP approach. As a result, the writers are given information in this study about factors to priorities utilizing the AHP technique. These seven criteria were selected after a thorough literature search and discussions with decision group experts. Figure 3 depicts how AHP responds to the problems.

The pairwise comparison is important for the AHP's design since it makes it possible to quantify impact criteria to level 1, which is a goal. In general, the stages demonstrate that a fair comparison between the criteria and the study purpose was made. As a result, the technique involves extracting a test for the major factors' consistency. The process step that improves pairwise comparisons of criteria and goal. The relative relevance of each criterion in relation to one another is also determined using the pairwise matrix. Table 1 demonstrates how significant and on what scale each number in [26] is valued.

This study will try to demonstrate how the adoption of internet banking ranks depending on the stated parameters by employing the AHP technique. This method can be used in the banking industry to assess service quality while also determining which service quality has the most impact on the services and requires the most

work to provide [27]. As a result, a variety of decision-related problems could be solved using this decision support technique. According to [21], the AHP is the best method and reasonable to apply to choose the right factors element when trying to resolve multiple factors in internet banking adoption. The superiority of the decision support method was demonstrated by paired pair assessments of expert-supported criteria. The AHP concept was also chosen because of its simple, logical, and transparent computation process.

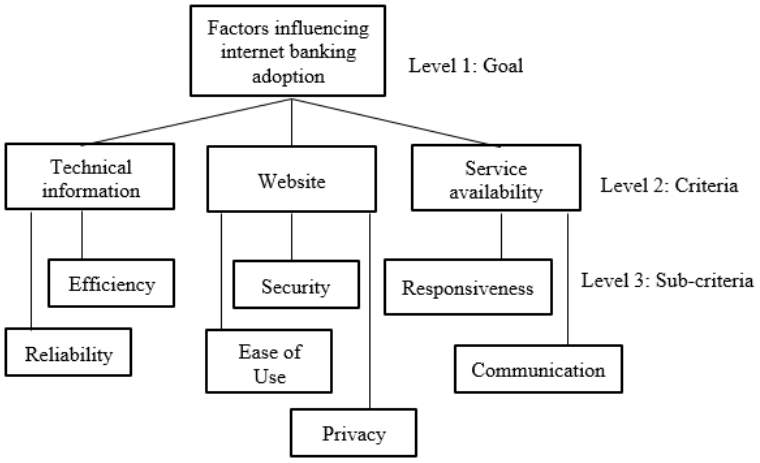

Figure 3. AHP process based on hierarchical tree

Table 1. Value of the score variable

Verbal judgement	Numeric value
Extremely important	9
	8
Very strong more important	7
	6
Strong more important	5
	4
Moderately more important	3
	2
Equally important	1

3. RESULTS AND DISCUSSION

Based on the AHP methodology, the findings of the adoption of online banking from Figure 1 are displayed below. To calculate this scale, use the [26] pairwise comparison scale as shown in Table 1. The scale is used to rank the relevance of and influence on decision-making of various factors. Table 2 contrasted pairwise primary criteria with a broad objective. Service availability achieved the greatest total out of those, with a matrix value of 6.0. This demonstrates that the goal is significantly influenced by the service availability. Website with matrix value 1.75 and technical information with matrix value 4.

A matched comparison of sub-criteria that are on the same level is required in the following phase as well. As shown in Tables 3, 4, and 5, there is a contrast. Table 3 shows that among the sub-criteria for technical information, reliability has the highest matrix value, 2.50, followed by efficiency, 1.67. Table 4 shows that privacy, with a matrix value of 5.00, is the website sub-criteria with the highest matrix value. Security is ranked third with a matrix score of 1.83, and ease of use is ranked second with a matrix value of 4.50. According to Table 5, among the service availability sub-criteria, responsiveness has the highest matrix value at 4.03, followed by communication at 1.33. The sub-criteria responsiveness with a matrix value 1 and communication with a same matrix value 1.

Table 2. Pairwise comparisons 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

Table 3. Technical information sub-criteria, pairwise comparison

Goal	Efficiency	Reliability
Efficiency	1	3/2
Reliability	0.06	1
Total	1.67	2.50

Table 4. Using pairwise comparisons, compare the website sub-criteria

Goal	Security	Ease of use	Privacy
Security	1	3	2
Ease of use	1/3	1	2
Privacy	½	1/2	1
Total	1.83	4.50	5.00

Table 5. Pairwise comparison for the sub-criteria of service availability

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

Tables 6 and 7 display the consistency ratio (CR) between the consistency index (CI) and random index (CI) for level 2 criteria (technical data, website accessibility, and service accessibility). According to the findings, the total of pairwise comparison of the criteria using a normalized matrix is 100% as Table 6, CR is 0.04 and CI is 0.025 as Table 7.

Table 6. Pairwise comparison of the criteria using a normalized matrix

Goal	Technical information	Website	Service availability	Priority
Technical information	0.25	0.27	017	23.41%
Website	0.50	0.55	0.67	57.94%
Service availability	0.25	0.18	017	18.65%
	Total			100%

Table 7. Calculation of λmax

Weighted-Sum (WS)	Priority (P)	WS/P	CI=(λmax-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	

Tables 8 and 9 display the CR between the CI and RI for the level 3 sub-criteria (efficiency and reliability). The results sub-criteria for technical data in pairwise normalized matrix comparison is 100% as Table 8, while CI and CR is demonstrated to be 0 as Table 9. The CR of the CI to the RI for level 3 sub-criteria (website) are shown in Tables 10 and 11. The results pairwise comparison of the normalized matrix for the website sub-criteria is 100% as Table 10, while CI is 0.07 and CR is 0.10 as Table 11.

Table 8. Sub-criteria for technical data in pairwise normalized matrix comparison

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

Table 9. Determining the λmax for the technical information sub-criteria

Weighted-Sum (WS)	Priority (P)	WS/P	CI=(λmax-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
			=0	

Table 10. Pairwise comparison of the normalized matrix for the website sub-criteria

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%
Privacy	0.27	0.11	0.2	19.46%
				=100%

Table 11. λmax for the website's sub-criteria calculation

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

Tables 12 and 13 display the consistency ratio (CR) of the consistency index (CI) to random index (RI) for the level 3 sub-criteria (service availability). The outcome for CI and CR is shown to be 0. Researchers [14], [28], [29] states that if CR indicates that less than 0.10, the judgements are acceptable with sufficiently consistent results. It must be revised and corrected if the CR is greater than 0.10. This essay establishes the efficacy and applicability of the priority's method to the model or framework.

Table 12. Pairwise comparison of the normalized matrix 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. λmax calculation for the sub-criteria for service availability

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	

The ranking-based factors are shown in Table 14. The ease-of-use element has the highest effect weight value (24.83%) among the comparison criteria. Communication is ranked last, with a weight value of 4.67%, and security is ranked second, with a weight value of 22.08%. This demonstrates that the most common strategy to influence the adoption of internet banking is through the aspect of usability. Researchers [16] have shown and offered proof that AHP could assist decision-makers in putting together choices to settle numerous conflicting issues.

Table 14. Ranking of factors

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

4. CONCLUSION

This study demonstrates the efficacy of the AHP approach for assessing variables influencing the adoption of online banking. This study successfully combines three levels of thought to access the ordering of priority. To address concerns with the adoption and evaluation of internet banking, it is anticipated that the new researchers will be able to enhance and broaden the AHP technique. The suggested tactic served to illustrate their capacity for making choices while identifying and weighing the greatest features. The approaches are thought to be appropriate for organizational decision-making. This mechanism method is used to identify factors in this paper. As we all know, the AHP technique uses prioritized rankings to handle multi-criteria for complicated decision problems. In addition, a hybrid approach or combination of methods

might be used to rank the criteria in a future study, and Sabah and Sarawak could be included in the study rather than only the Klang Valley, Selangor, and Kuala Lumpur.

REFERENCES

[1] A. Sundara and A. Perera, "The factors influencing on the customer adoption of internet banking system special reference to the Sampath bank in Colombo district," *International Journal of Scientific and Research Publications*, vol. 8, no. 2, 2018.

[2] E. K. Yarimoglu, "A review on dimensions of service quality models," *Journal of Marketing Management*, vol. 2, no. 2, pp. 79–93, 2014.

[3] C. R. Algarín, A. P. Llanos, and A. O. Castro, "An analytic hierarchy process based approach for evaluating renewable energy sources," *International Journal of Energy Economics and Policy*, vol. 7, no. 4, pp. 38–47, 2017.

[4] V. Skvarciany and D. Jurevičienė, "Factors influencing individual customers trust in internet banking: case of Baltic states," *Sustainability*, vol. 10, no. 12, Dec. 2018, doi: 10.3390/su10124809.

[5] J. Hammoud, R. M. Bizri, and I. El Baba, "The impact of E-banking service quality on customer satisfaction: evidence from the Lebanese banking sector," *SAGE Open*, vol. 8, no. 3, Apr. 2018, doi: 10.1177/2158244018790633.

[6] E. Fernando and P. Siagian, "Proposal to use the analytic hierarchy process method evaluate bank credit submissions," *Procedia Computer Science*, vol. 179, pp. 232–241, 2021, doi: 10.1016/j.procs.2021.01.002.

[7] M. Nilashi, H. Ahmadi, A. Ahani, O. Ibrahim, and A. Almaee, "Evaluating the factors affecting adoption of hospital information system using analytic hierarchy proces," *Journal of Soft Computing and Decision Support Systems*, vol. 3, no. 1, pp. 8–35, 2015.

[8] A. R. Bhagwat and M. Hedau, "AHP model on the assessment of technological innovation in banking sector (with reference to Indian and foreign banks," vol. 10, no. 3, pp. 424–429, 2022.

[9] I. Canco, D. Kruja, and T. Iancu, "AHP, a reliable method for quality decision making: a case study in business," *Sustainability (Switzerland)*, vol. 13, no. 24, pp. 1–15, 2021, doi: 10.3390/su132413932.

[10] M. Chavosh Nejad, S. Mansour, and A. Karamipour, "An AHP-based multi-criteria model for assessment of the social sustainability of technology management process: a case study in banking industry," *Technology in Society*, vol. 65, May 2021, doi: 10.1016/j.techsoc.2021.101602.

[11] A. Calabrese, R. Costa, N. Levialdi, and T. Menichini, "Integrating sustainability into strategic decision-making: a fuzzy AHP method for the selection of relevant sustainability issues," *Technological Forecasting and Social Change*, vol. 139, pp. 155–168, 2019, doi: 10.1016/j.techfore.2018.11.005.

[12] M. D. Cohen, J. G. March, and J. P. Olsen, "A garbage can model of organizational choice," *Administrative Science Quarterly*, vol. 17, no. 1, Mar. 1972, doi: 10.2307/2392088.

[13] T. L. Saaty, "How to make a decision: the analytic hierarchy process," *European Journal of Operational Research - North-Holland*, vol. 48, pp. 9–26, 1990.

[14] R. W. Saaty, "The analytic hierarchy process-what it is and how it is used," *Mathematical Modelling*, vol. 9, no. 3–5, pp. 161–176, 1987, doi: 10.1016/0270-0255(87)90473-8.

[15] M. Azadi *et al.*, "An analytic hierarchy process (AHP) approach to a real world supplier selection problem: a case study of Carglass Turkey," *International Journal of Industrial and Systems Engineering*, vol. 6, no. 39944, pp. 365–376, 2014.

[16] S. Wang *et al.*, "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*, vol. 7, no. 2, Feb. 2018, doi: 10.3390/ijgi7020050.

[17] A. Khaira and R. K. Dwivedi, "A state of the art review of analytical hierarchy proces," *Materials Today: Proceedings*, vol. 5, no. 2, pp. 4029–4035, 2018, doi: 10.1016/j.matpr.2017.11.663.

[18] M. Kumar and S. Gupta, "Security perception of e-banking users in India: an analytical hierarchy process," *Banks and Bank Systems*, vol. 15, no. 1, pp. 11–20, Feb. 2020, doi: 10.21511/bbs.15(1).2020.02.

[19] I. Syamsuddin and J. Hwang, "The application of AHP model to guide decision makers: a case study of E-banking security," in *2009 Fourth International Conference on Computer Sciences and Convergence Information Technology*, 2009, pp. 1469–1473, doi: 10.1109/ICCIT.2009.251.

[20] J. Wang, W. Bai, and Y. Liu, "Optimization for the human resources management strategy of the IoT industry based on AHP," *Computational Intelligence and Neuroscience*, vol. 2022, no. 2, 2022, doi: 10.1155/2022/3514285.

[21] S. N. F. Zuraidi, M. A. A. Rahman, and Z. A. Akasah, "A study of using AHP method to evaluate the criteria and attribute of defects in heritage building," *E3S Web of Conferences*, vol. 65, Nov. 2018, doi: 10.1051/e3sconf/20186501002.

[22] S. Faizi, T. Rashid, and S. Zafar, "A multicriteria decision-making approach based on fuzzy AHP with intuitionistic 2-tuple linguistic sets," *Advances in Fuzzy Systems*, vol. 2018, pp. 1–12, Aug. 2018, doi: 10.1155/2018/5789192.

[23] A. A. Longaray, J. de D. R. Gois, and P. R. da S. Munhoz, "Proposal for using AHP method to evaluate the quality of services provided by outsourced companies," *Procedia Computer Science*, vol. 55, pp. 715–724, 2015, doi: 10.1016/j.procs.2015.07.083.

[24] E. K. Zavadskas, K. Govindan, J. Antucheviciene, and Z. Turskis, "Hybrid multiple criteria decision-making methods: a review of applications for sustainability issues," *Economic Research-Ekonomska Istrazivanja*, vol. 29, no. 1, pp. 857–887, 2016, doi: 10.1080/1331677X.2016.1237302.

[25] N. Yaghubi and S. M. Seyedin, "Ranking the technical dimensions of E-banking service quality evaluation models using analytical hierarchy process," *Advances in Computer Science : An International Journal*, vol. 4, no. 1, 2015.

[26] K. Kulakowski, *Understanding the analytic hierarchy process*, no. 2012. Chapman and Hall/CRC, 2020.

[27] F. A. Haery, H. Ghorbani, and A. A. Farahmand, "An AHP approach for ranking critical success factors of customers experience in Iranian banks from managers' viewpoint," *International Journal of Marketing Studies*, vol. 6, no. 1, pp. 168–176, Jan. 2014, doi: 10.5539/ijms.v6n1p168.

[28] H. Taherdoost, "Decision making using the analytic hierarchy process (AHP); a step by step approach," *Journal of Economics and Management Systems*, vol. 2, pp. 244–246, 2017.

[29] T. Sharma, Z. Khan, J. George, and P. Badoniya, "Integration of analytical hierarchy process (AHP) and technique for order preference by similarity to ideal solution (TOPSIS) for supplier selection," *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 2018.

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