

AN INTEGRATED FUZZY DEMATEL AND FUZZY TOPSIS METHOD FOR ANALYZING STUDENTS' MOBILE BANKING PROVIDER PREFERENCES

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Abstract: *The increasing use of mobile banking among university students has created a need to understand the factors that shape their preferences for banking applications. This study evaluates students' preferences for mobile banking providers by integrating the Fuzzy Decision-Making Trial and Evaluation Laboratory (Fuzzy DEMATEL) and Fuzzy Technique for Order Preference by Similarity to the Ideal Solution (Fuzzy TOPSIS) methods. Fuzzy DEMATEL is first applied to determine the relative weights and causal relationships among five evaluation criteria: accessibility, features and functionality, security, transaction speed, and user-friendly. The resulting criterion weights are subsequently incorporated into Fuzzy TOPSIS to rank three mobile banking providers: Bank Islam Malaysia Berhad, Malayan Banking Berhad (Maybank), and RHB Bank Berhad. Data were collected via an online questionnaire from five purposively sampled UiTM Cawangan Kelantan students with experience using all three selected providers. The Fuzzy DEMATEL results classify features and functionality, security, and transaction speed as cause criteria, while accessibility and user-friendliness are classified as effect criteria. Accessibility obtained the highest relative weight (0.2092), followed by user-friendly (0.2030), features and functionality (0.2025), security (0.1949), and transaction speed (0.1904). The Fuzzy TOPSIS results show that Maybank achieved the highest closeness coefficient (0.8909), followed by RHB Bank (0.4511) and Bank Islam (0.1060). The findings indicate that integrating causal analysis with preference ranking provides a structured approach for examining interrelated mobile banking evaluation criteria and can assist banking institutions in identifying areas for service improvement.*

Keywords: *Fuzzy DEMATEL; Fuzzy TOPSIS; Mobile Banking; Student Preferences; Multi-Criteria Decision-Making*

Introduction

Mobile banking has become an important channel for accessing financial services because it enables customers to perform activities such as checking account balances, transferring funds, paying bills and receiving notifications through mobile devices. The expansion of smartphones and mobile applications has made banking services increasingly accessible and convenient, while also changing users' expectations regarding speed, security and ease of use. Previous research has examined mobile banking adoption, service quality, continuance intention and customer loyalty from different theoretical and methodological perspectives (Shaikh & Karjaluoto, 2015; Tam & Oliveira, 2017; Owusu Kwateng et al., 2019; Jebarajakirthy & Shankar, 2021).

University students represent an important user group because mobile banking supports everyday financial activities in a highly digital environment. However, users do not necessarily evaluate banking applications on a single factor. Accessibility, functionality, security, transaction speed and usability may interact with one another and jointly influence overall preference. Studies have identified ease of use, perceived usefulness, trust, security, functionality and performance as relevant factors in mobile banking adoption and evaluation (Ho et al., 2020; Zhu et al., 2020; Roy & Shaw, 2021; Roy & Shaw, 2023).

Although Fuzzy DEMATEL and Fuzzy TOPSIS have each been applied to decision-making and banking-related evaluation problems, the present study applies them sequentially to a student mobile banking preference problem. Fuzzy DEMATEL is used to capture causal interrelationships among the criteria and derive their relative weights, whereas Fuzzy TOPSIS uses those weights to determine the relative closeness of alternative mobile banking providers to an ideal solution.

The study focuses on students at Universiti Teknologi MARA (UiTM) Cawangan Kelantan. The selection of five respondents was considered appropriate for the exploratory decision-making component of this study because the survey aimed to obtain informed individual assessments rather than estimate population-level parameters.

Three mobile banking providers were evaluated: Bank Islam Malaysia Berhad, Malayan Banking Berhad (Maybank), and RHB Bank Berhad. The study has two objectives: (i) to calculate the relative weights of the criteria using Fuzzy DEMATEL; and (ii) to rank students' preferences for mobile banking providers using Fuzzy TOPSIS.

Literature Review

Mobile banking refers to banking services delivered through mobile technology, allowing customers to conduct financial activities without being restricted to a physical branch. Tam and Oliveira (2017) describe mobile banking as an important digital channel associated with individual performance, while Shaikh and Karjaluoto (2015) highlight the development of mobile banking research around adoption and user-related factors. Research has also shown that mobile banking can provide convenience and accessibility while creating concerns relating to security, usability and perceived risk (Esmaeili et al., 2021; Jebarajakirthy & Shankar, 2021).

The quality of mobile banking services is multidimensional. Mostafa (2020) examined mobile banking service quality and customer value co-creation, while Roy and Shaw (2021) considered functionality, convenience, performance expectancy, performance quality, security and compatibility in evaluating mobile banking applications. Roy and Shaw (2023) further applied a fuzzy multi-criteria decision-making model to compare mobile banking applications.

Five criteria were selected for this study; accessibility, features and functionality, security, transaction speed, and user-friendly. Accessibility concerns convenient access to banking services, features and functionality concern functions such as transfers, bill payments and account management, security concerns protection against unauthorized access, transaction speed concerns processing time, and user-friendly concerns interface simplicity and ease of navigation.

The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method is a widely used multi-criteria decision-making (MCDM) technique for analysing complex causal relationships among criteria. It helps identify cause-and-effect relationships among factors using crisp, accurate data collected from experts or numerical sources. DEMATEL is a multi-criteria decision-making method designed to analyse complex relationships among factors and distinguish cause criteria from effect criteria (Wu & Lee, 2007). Its fuzzy extension represents uncertainty and vagueness in human judgments.

The Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) was first established by Hwang and Yoon in 1981 to rank alternatives by comparing their proximity to ideal solutions (Tzeng and Huang, 2011). Fuzzy TOPSIS will then rank the alternatives according to their relative closeness to a positive ideal solution and distance from a negative ideal solution (Chen, 2000; Nadaban et al., 2016). Both methods above have been applied to technology, service and banking evaluation problems.

Methodology

This study employed a multi-criteria decision-making (MCDM) approach that integrated the fuzzy decision-making trial and evaluation laboratory (Fuzzy DEMATEL) and the fuzzy technique for order preference by similarity to the ideal solution (Fuzzy TOPSIS) to evaluate interdependencies among criteria and rank mobile banking providers. The framework consists of three sequential phases:

Phase I: Identification of Criteria, Alternatives and Data Collection

Five core criteria were identified from the literature: Accessibility (C_1), Features and Functionality (C_2), Security (C_3), Transaction Speed (C_4), and User-Friendliness (C_5). Three popular mobile banking platforms among Universiti Teknologi MARA (UiTM) Cawangan Kelantan students were selected as alternatives: Bank Islam Malaysia Berhad (A_1), Malayan Banking/Maybank (A_2), and RHB Bank (A_3). Figure 1 illustrates the hierarchical structure for mobile banking selection.

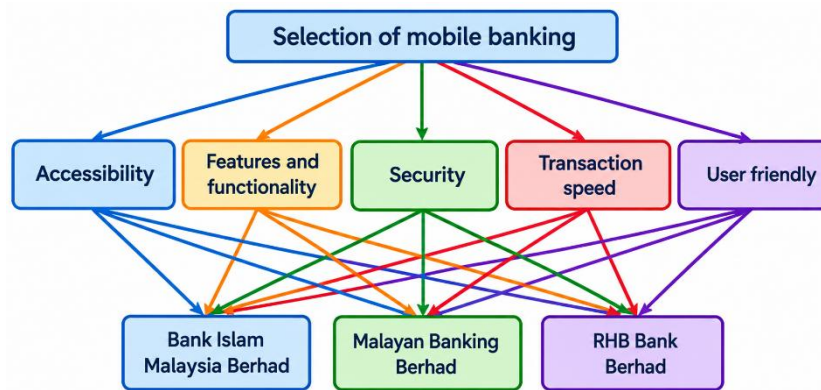


Figure 1: Hierarchy Structure for Mobile Banking Selection

Primary data were gathered via a structured questionnaire administered to a panel of five student users from UiTM Cawangan Kelantan who were purposively selected based on their active, hands-on experience using all three evaluated platforms. In fuzzy MCDM frameworks such as fuzzy DEMATEL and fuzzy TOPSIS, respondent selection prioritizes depth of platform familiarity over statistical sample size. Unlike inferential statistical surveys that require a large sample size (N) to estimate population parameters, expert-based MCDM methods rely on small, qualified panels (typically 3 to 10 evaluators) to model complex causal structures and evaluate alternatives without statistical sampling assumptions (Wu & Lee, 2007; Tzeng & Huang, 2011; Abdullah et al., 2023; Roy & Shaw, 2023). The linguistic evaluations gathered from the panel were converted into triangular fuzzy numbers (TFNs) following Abdullah et al. (2023) to aggregate the panel's preferences while accommodating the vagueness of human judgment.

Phase II: Weight Determination using Fuzzy DEMATEL

Fuzzy DEMATEL was applied to model the interrelationship among criteria and derive their relative weights through the following steps:

Step 1: Fuzzy Direct-Relation Matrix Construction

The fuzzy direct-relation matrices are constructed from linguistic evaluations gathered from experts. Each assessment was converted into triangular fuzzy numbers (TFNs) following Abdullah et al. (2023), as shown in Table 1.

Table 1: The Linguistic Terms and Triangular Fuzzy Numbers (TFNs)

Linguistic Term	Triangular Fuzzy Number
No influence (NO)	(0.0, 0.1, 0.3)
Very low influence (VL)	(0.1, 0.3, 0.5)
Low influence (L)	(0.3, 0.5, 0.7)
High influence (H)	(0.5, 0.7, 0.9)
Very high influence (VH)	(0.7, 0.9, 1.0)

Source: (Abdullah et al., 2023)

Subsequently, the evaluations were compiled into individual fuzzy direct-relation matrices (Z^1 , Z^2 , ..., Z^k) where each matrix is of size $n \times n$ where n represents the total number of criteria as shown in (1).

$$Z^k = \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{matrix} \begin{bmatrix} [0,0,0] & x_{12}^k & \cdots & x_{1n}^k \\ x_{21}^k & [0,0,0] & \cdots & x_{2n}^k \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1}^k & x_{n2}^k & \cdots & [0,0,0] \end{bmatrix} \quad (1)$$

Step 2: Normalization and Defuzzification

TFNs matrices were normalized using max-min scaling and converted into crisp values using left and right normalized scores. The normalization is carried out by identifying the range of the fuzzy values using (2), then applying the normalization formula in (3), (4), and (5) for the lower, middle, and upper bounds, respectively.

Max – min range:

$$\Delta_{\min}^{\max} = \max r_{ij}^k - \min l_{ij}^k \quad (2)$$

Normalization for lower bound:

$$xl_{ij}^k = \frac{l_{ij}^k - \min l_{ij}^k}{\Delta_{\min}^{\max}} \quad (3)$$

Normalization for middle bound:

$$xm_{ij}^k = \frac{m_{ij}^k - \min l_{ij}^k}{\Delta_{\min}^{\max}} \quad (4)$$

Normalization for upper bound:

$$xr_{ij}^k = \frac{r_{ij}^k - \min l_{ij}^k}{\Delta_{\min}^{\max}} \quad (5)$$

Further processing of the normalized fuzzy direct-relation matrix yields the left and right normalized scores. These scores are necessary to more accurately determine the influence levels among the criteria. The calculations are performed using (6) for the left-normalized scores and (7) for the right-normalized scores.

Left-normalized score:

$$xls_{ij}^k = \frac{xm_{ij}^k}{(1 + xm_{ij}^k - xl_{ij}^k)} \quad (6)$$

Right-normalized score:

$$xrs_{ij}^k = \frac{xr_{ij}^k}{(1 + xr_{ij}^k - xm_{ij}^k)} \quad (7)$$

The left and right normalized scores obtained from the fuzzy direct-relation matrices are converted into crisp values to quantify the overall influence of one criterion over another. The crisp value serves as a defuzzified result, combining the pessimistic (left) and optimistic (right) views into a single interpretable metric. The crisp value for the relationship between criterion i and criterion j , based on the judgment of expert k , is calculated using (8).

$$x_{ij}^k = \frac{xls_{ij}^k * (1 - xls_{ij}^k) + xrs_{ij}^k * xrs_{ij}^k}{(1 - xls_{ij}^k + xrs_{ij}^k)} \quad (8)$$

Step 3: Total Relation Matrix Computation

Aggregated rescaled crisp matrices were standardized (X) and used to compute the total relation matrix, $T = X(1 - X)^{-1}$.

Step 4: Causal Analysis and Weight Calculation

For each criterion, row sums (R_i) and column sums (D_i) were derived to determine the center degree ($R_i + D_i$), cause degree ($R_i - D_i$), and group classification (cause or effect). Relative criteria weights (W_i) were calculated by normalizing $R_i + D_i$ values. The relative weights of each criterion are computed using (9), where n is the number of criteria.

$$W_i = \frac{R_i + D_i}{\sum_{i=1}^n R_i + D_i} \quad (9)$$

Phase III: Alternative Ranking using Fuzzy TOPSIS

Fuzzy TOPSIS was implemented to evaluate and rank the alternatives through the following steps:

Step 1: Fuzzy Decision Matrix

Linguistic performance ratings of alternatives against criteria were converted into a triangular fuzzy number (TFNs) and aggregated. Each linguistic term is then converted into TFNs as shown in Table 2.

Table 2: The Linguistic Terms and Triangular Fuzzy Numbers (TFNs)

Linguistic Term	Triangular Fuzzy Number
Very low (VL)	(1, 1, 3)
Low (L)	(1, 3, 5)
Medium (M)	(3, 5, 7)
High (H)	(5, 7, 9)
Very high (VH)	(7, 9, 9)

Source: (Abdullah et al., 2023)

Then, the fuzzy decision matrix (D) is developed using (10) to represent the aggregated fuzzy evaluations of each alternative (A_i) under each criterion (C_j) based on the inputs from multiple experts where m is the number of alternatives and n is the number of criteria.

$$C_1 \quad C_2 \quad \cdots \quad C_n \quad (10)$$

$$D = \begin{bmatrix} A_1 & \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ A_2 & \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ A_m & \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}$$

Step 2: Normalization and Weighting

The matrix was normalized, denoted as R . The normalization can be performed using equation (12).

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+} \right) \text{ where } c_j^+ = \max(c_{ij}) \quad (11)$$

$$R = [\tilde{r}_{ij}]_{m \times n}, i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (12)$$

Then, R is multiplied by the Fuzzy DEMATEL criterion weights (W_i) to yield the weighted normalized matrix, V as shown in (13) and (14).

$$\tilde{v}_{ij} = \tilde{r}_{ij} \times W_i \quad (13)$$

$$V = [\tilde{v}_{ij}] \quad (14)$$

where $i = 1, 2, \dots, m; j = 1, 2, \dots, n$ and W_i is the weight.

Step 3: Ideal Solutions and Distance Calculation

Fuzzy positive ideal solutions (FPIS, A^+) and fuzzy negative ideal solutions (FNIS, A^-) were determined.

$$A^+ = (\tilde{v}_1^+, \tilde{v}_2^+, \dots, \tilde{v}_n^+) \quad (15)$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-) \quad (16)$$

where

$$\tilde{v}_j^+ = \max_i(\tilde{v}_{ij}) \text{ and } \tilde{v}_j^- = \min_i(\tilde{v}_{ij})$$

$$i = 1, 2, \dots, m; j = 1, 2, \dots, n$$

Distances from A^+ (d_i^+) and A^- (d_i^-) were calculated using the vertex method.

$$d(a, b) = \sqrt{\frac{1}{3} \left[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2 \right]} \quad (17)$$

$$d_i^+ = \sum_{j=1}^n d_v(\tilde{v}_{ij}, \tilde{v}_j^+) \quad (18)$$

$$d_i^- = \sum_{j=1}^n d_v(\tilde{v}_{ij}, \tilde{v}_j^-)$$

Step 4: Closeness Coefficient Calculation

The relative closeness coefficients, CC_i were derived using (19) to establish the final ranking of alternatives.

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}, i = 1, 2, \dots, m \quad (19)$$

Results and Discussion

Fuzzy DEMATEL for Weight Calculation

Table 3 presents the results of the analysis of the five evaluation criteria obtained using the Fuzzy DEMATEL method. The cause degree ($R_i - D_i$) identifies whether a criterion belongs to the cause group if the value is positive or effect group if the is negative. Then the weight (W_i) represents the relative importance of each criterion based on its influence within the mobile banking system. These weights were then applied in the Fuzzy TOPSIS method to rank the alternative mobile banking providers.

Table 3: Values of R_i , D_i , $R_i + D_i$ and $R_i - D_i$

	Criteria	Cause Degree	Group	W_i
C ₁	Accessibility	-2.1941	Effect	0.2092
C ₂	Features and functionality	0.5969	Cause	0.2025
C ₃	Security	1.8940	Cause	0.1949
C ₄	Transaction speed	3.6223	Cause	0.1904
C ₅	User-friendly	-3.9191	Effect	0.2030

Based on the cause degree values, features and functionality (C₂), security (C₃), and transaction speed (C₄) were classified in the cause group, indicating that these criteria significantly influence other factors in the mobile banking system. In other words, they function as driving criteria, and improvements in these areas are likely to trigger positive effects on the remaining criteria.

Among these, transaction speed recorded the highest cause degree value of 3.6256, highlighting its strong influence within the system. This suggests that students prioritize fast and seamless transactions, which may shape their overall perception of mobile banking. Security with a cause degree of 1.8937, follows as another key driver, implying that trust and data protection are essential components in shaping user confidence. Meanwhile, features and functionality with a cause degree of 0.6000, also play a vital role, although to a slightly lesser extent.

In contrast, accessibility (C₁) and user-friendly (C₅) fall under the effect group, as they exhibit negative cause degree values of -2.1941 and -3.9191, respectively. This indicates that they are dependent criteria, meaning that their effectiveness is shaped by improvements in the cause group. User-friendliness is the most influential criterion in the system, since it has the highest negative cause degree. These findings suggest that improving transaction speed, security, and features and functionality will likely enhance user-friendliness and accessibility. Thus, the overall student experience in mobile banking services increases.

Regarding the weights (W_i), accessibility received the highest weight, followed by user-friendly, features and functionality, security, and finally transaction speed. Accessibility, with the highest weight of 0.2092, indicates that ease of access is a fundamental expectation in mobile banking services among students. This finding is partially supported by Roy and Shaw (2021), who identified convenience as one of the most significant factors in evaluating m-banking applications. While the terminology differs, both constructs emphasize ease of access and use, supporting the importance of user-centered design and straightforward navigation in m-banking platforms.

Transaction speed, despite being the most influential criterion due to its highest cause degree, has the lowest weight, 0.1904. This finding indicates a discrepancy between a criterion's influence within the system and its perceived importance from the user perspective. This contrast arises because the DEMATEL-based weighting method incorporates both direct and indirect interrelationships among criteria, rather than relying solely on subjective preference ratings.

Fuzzy TOPSIS for Ranking Alternatives

Table 4: Closeness Coefficient and Ranking of Alternatives

	Alternative	CC_i	Rank
A ₁	Bank Islam Malaysia Berhad	0.1060	3
A ₂	Malayan Banking Berhad	0.8909	1
A ₃	RHB Bank Berhad	0.4511	2

Table 4 presents the analysis results of the three evaluation alternatives obtained using the Fuzzy TOPSIS method. The closeness coefficient represents how close each alternative is to the ideal solution. A higher CC_i indicates a better overall performance based on the weighted evaluation criteria. Based on the results, Malayan Banking Berhad (A₂) achieved the highest closeness coefficient of 0.8909, indicating it is the most preferred mobile banking provider among students. This implies that Maybank outperformed the other two alternatives in terms of both influence and importance across all evaluated criteria. RHB Bank Berhad (A₃) ranked second with a moderate closeness coefficient of 0.4511, suggesting that while it performs better than Bank Islam, it still falls behind Maybank in meeting students' expectations.

Bank Islam Malaysia Berhad (A₁) received the lowest score of 0.1060, indicating a considerable gap from the ideal solution. This may be due to lower performance on criteria that students considered more important, such as accessibility or transaction speed. These findings underscore the significance of evaluating alternatives not only through direct preferences but also by considering the causal structure of criteria. These rankings offer valuable insights into students' preferences regarding mobile banking services. They can serve as a practical reference for banks to identify which areas require improvement to better meet the expectations of student users.

Conclusion

This study applied an integrated Fuzzy DEMATEL and Fuzzy TOPSIS framework to evaluate university students' preferences for mobile banking providers. The first objective, to calculate relative criterion weights using Fuzzy DEMATEL, was achieved. Features and functionality,

security and transaction speed were identified as cause criteria, whereas accessibility and user-friendly were identified as effect criteria. Accessibility had the highest relative weight, 0.2092. The second objective, to rank the selected mobile banking providers using Fuzzy TOPSIS, was also achieved. Maybank obtained the highest closeness coefficient (0.8909) and ranked first, followed by RHB Bank (0.4511) and Bank Islam (0.1060). The findings demonstrate how Fuzzy DEMATEL can incorporate interrelationships among criteria before Fuzzy TOPSIS ranks alternatives. The principal limitation is the small purposive sample of five UiTM Cawangan Kelantan students and the focus on three banking providers. The findings should therefore be regarded as exploratory. Future research should involve larger and more diverse samples, additional banking alternatives, comparisons across user segments, and robustness checks using other MCDM methods such as Fuzzy AHP, Fuzzy ANP or Fuzzy VIKOR.

References

- Abdullah, F. M., Al-Ahmari, A. M., & Anwar, S. (2023). Analyzing interdependencies among influencing factors in smart manufacturing. *Sustainability*, 15(4), 3864.
- Chen, C.-T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. *Fuzzy Sets and Systems*, 114(1), 1–9.
- Esmaeili, A., Haghighoo, I., Davidaviciene, V., & Meidute-Kavaliauskiene, I. (2021). Customer loyalty in mobile banking: Evaluation of perceived risk, relative advantages, and usability factors. *Engineering Economics*, 32(1), 70–81.
- Ho, J. C., Wu, C.-G., Lee, C.-S., & Pham, T.-T. T. (2020). Factors affecting the behavioral intention to adopt mobile banking: An international comparison. *Technology in Society*, 63, 101110.
- Jebarajakirthy, C., & Shankar, A. (2021). Impact of online convenience on mobile banking adoption intention: A moderated mediation approach. *Journal of Retailing and Consumer Services*, 58, 102323.
- Mostafa, R. B. (2020). Mobile banking service quality: A new avenue for customer value co-creation. *International Journal of Bank Marketing*, 38(5), 1107–1132.
- Nadaban, S., Dzitac, S., & Dzitac, I. (2016). Fuzzy TOPSIS: A general view. *Procedia Computer Science*, 91, 823–831.
- Noor, M. M. (2011). Determining critical success factors of mobile banking adoption in Malaysia. *Australian Journal of Basic and Applied Sciences*, 5(9), 252–265.
- Owusu Kwateng, K., Osei Atiemo, K. A., & Appiah, C. (2019). Acceptance and use of mobile banking: An application of UTAUT2. *Journal of Enterprise Information Management*, 32(1), 118–151.
- Roy, P., & Shaw, K. (2023). A fuzzy MCDM decision-making model for m-banking evaluations: Comparing several m-banking applications. *Journal of Ambient Intelligence and Humanized Computing*, 14(9), 11873–11895.
- Roy, P. K., & Shaw, K. (2021). An integrated fuzzy model for evaluation and selection of mobile banking applications using new fuzzy-BWM and fuzzy-TOPSIS. *Complex & Intelligent Systems*, 1–22.
- Shaikh, A. A., & Karjaluoto, H. (2015). Mobile banking adoption: A literature review. *Telematics and Informatics*, 32(1), 129–142.
- Tam, C., & Oliveira, T. (2017). Literature review of mobile banking and individual performance. *International Journal of Bank Marketing*, 35(7), 1044–1067.
- Tzeng, G.-H., and Huang, J.-J. (2011). Multiple attribute decision making: methods and applications. CRC press.
- Wu, W.-W., & Lee, Y.-T. (2007). Developing global managers' competencies using the fuzzy DEMATEL method. *Expert Systems with Applications*, 32(2), 499–507.

Zhu, X., Yan, R., & Xu, T. X. (2020). An integrated DEMATEL-ANP approach for mobile banking adoptions in China market. *Discrete Dynamics in Nature and Society*, 2020, 1–11.