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Improving Service Quality of Wealth Management Bank for High-Net-Worth Customers During COVID-19: A Fuzzy-DEMATEL Approach

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Abstract The 2019–2020 COVID-19 pandemic has caused an economic turndown and high volatility in the global financial markets. Determining the factors that influence services to high-net-worth customers who typically have large investments in the financial markets is important for wealth management banks. This study constructs a hybrid approach by integrating the fuzzy logic and Decision-making Trial and Evaluation Laboratory (DEMATEL) methods to identify the most influential criteria affecting the performance of wealth management banks in Taiwan during the 2019–2020 COVID-19 pandemic. Surveys and interviews are designed using four dimensions (bank performance, service quality, customer relationship, and COVID-19) and 16 criteria for 10 banking executives using fuzzy linguistic scales, to obtain their expert opinions. The results show the order of influence as being service quality, customer relationships, bank performance, and COVID-19. The most important criteria are customized investment information (in-service quality), switching behavior (in-customer relationship), fee income (in-bank performance), and the number of confirmed cases in the top five countries affected by COVID-19. The managerial implication is that wealth management banks should focus on improving their service quality. Banks may strive to provide a wide range of customized investment information and increase customers' usage of personalized financial products and services. The results of this study will benefit bank managers in serving high-net-worth individuals during the crisis period.

Keywords COVID-19 · Wealth management · High-net-worth individuals · Fuzzy-DEMATEL · Fuzzy linguistic scales

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1 Introduction

The coronavirus disease 2019 (COVID-19), which began in December 2019, is an infectious disease that has caused an outbreak of respiratory illness and resulted in an ongoing pandemic [1].

As of September 3, 2020, more than 20 million cases had been reported across 188 countries and territories, resulting in more than 863,000 deaths [1]. COVID-19 caused a substantial decline in global economic activity. Consequently, the global stock markets experienced their largest fall in February and March 2020 since the 2008 global financial crisis. For example, the Dow Jones Industrial Average Index (DJIAI) and the Standard and Poor 500 Index (S&P 500I) both plunged by more than 30% in March 2020, from their record high in the previous month [2]. Investors sold stocks because they feared that the economic fall-out from COVID-19 outpaced the remedies from the governments [3].

Prior studies have analyzed the financial and economic decline that began with the 2008 U.S. sub-prime crisis and that caused global financial turmoil [4–7]. The fall in the

stock market caused financial losses for banks and investors [8]. For instance, Trendowski and Nair [9] studied the extent to which governments changed their policies and banks modified their practices for customers in response to the 2008 financial turbulence. In general, banks became more conservative in their practices by reducing interest-bearing loans for fear of increasing credit risk. Banks began to promote products and services, such as wire transfers, stocks, mutual fund trading, and financial advisory services, to generate non-interest income.

Banks worldwide began to rely more on fee-income financial products and services to provide a stable source of income [9, 10]. Financial failure and intensified competition in the traditional banking industry caused banks with a focus on loans to experience shrinking profits after the 2008 financial crisis [11, 12].

For example, the U.S. bank holding companies that offered both commercial and investment banking services, such as Bank of America Holdings, actively charged customers fees to compensate for the diminishing loan business. Banks that faced pressure during the 2008 financial crisis diversified their sources of revenue to stabilize their income and the returns of the banks' investors [12].

Kotarba [13] addressed the changes initiated by banks after the 2008 financial crisis. One of the notable examples is Financial Technology (Fin-Tech), which serves customers through digital tools.

The 2008 financial crisis weakened consumers' confidence in banking services and reduced the opportunities for banks to manage investable funds. The banks' response was to ensure internal security, increase their customers' trust in the bank, and use technology instead of humans to retain their customers [14].

Wealth management banks have grown rapidly in Asian countries such as Singapore and Hong Kong, because these countries were relatively unscathed by the 2008 financial crisis [15, 16].

Similarly, several major Taiwanese financial holding companies have developed their divisions of wealth management in the past decade as a result of the growth of Taiwanese business assets [17]. The Taiwan wealth management banks have experienced an average growth of 12.1% since 2015, which exceeds the global average growth rate of 6.4% [17]. Wealth management banks typically classify their high-net-worth individuals into three classes. The first-class customers are those who usually have a combined balance of US$1 million in a particular bank [18]. The second class of customers has a combined balance of at least US$300,000. The third class of customers holds a minimum balance of US$100,000. Wealth management banks provide high-net-worth individuals and their family members with customized services in portfolio management, investment strategy, asset allocation, estate planning, and tax consulting [19, 20].

Therefore, wealth management products generally include stock transactions, bond transactions, mutual funds, Exchange-Traded Funds (ETF), stock-linked investments, foreign exchange, derivatives, trusts and loans. Banks tend to provide wealth management customers with greater discounts on banking services, as well as non-financial personal services such as airport pickup services, travel arrangements, and discounts in stores [12, 21].

The negative impact of COVID-19 on financial markets (stocks and bonds) is similar to that of the 2008 financial crisis. Previous studies have examined the degree to which the 2008 financial crisis altered banking services and behavior [9, 19, 21–23]. Chang and Tsai [24] utilized a hybrid approach with an Analytic Hierarchy Process (AHP) and VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) to evaluate the financial performance of wealth management affected by the 2008 global financial crisis. Ting [19] and Wu et al. [21] applied AHP to analyze the Taiwanese wealth management banks after the 2008 global financial crisis, while Stankevičienė and Mencaitė [22], Dinçer et al. [25] adopted the AHP and fuzzy-AHP models to evaluate the performance of European banks. Researchers scrutinized the wealth management banks from their finances, customers, business processes and learning and growth stated from the Balanced Scorecard (BSC). Liu and Teng [24] used a novel multiple attribute decision-making (MADM) method to rank consumer products based on online product reviews (OPRs). However, limited studies have examined the impact of COVID-19 on banking practices. This study fills the gap by evaluating the ways in which Taiwanese wealth management banks have revised their practices due to the changes that have been incurred by the COVID-19 pandemic.

The purpose of this study is to identify the most influential criteria affecting the Taiwanese wealth management banks in serving high-net-worth individuals during the 2019–2020 COVID-19 pandemic. This study selects four dimensions (bank performance, service quality, customer relationship, and COVID-19) and 16 criteria (number of customers, customer assets, fee income, commission income, customer satisfaction, innovation, customized investment information, family financial planning, customer engagement, relationship bond, benefit of switching, cost of switching, switching behavior, number of confirmed cases worldwide, number of confirmed cases in the top five nations, and Taiwanese rate of transmission) to evaluate bank performance. We surveyed and interviewed 10 experts in the banking industry to solicit their opinions on banking services in which COVID-19 has affected the wealth management in Taiwan.

This study includes COVID-19 as a separate dimension because although this paper assumes that bank managers modified their practices to cope with COVID-19, the authors of this study aim to identify the level of influence COVID-19 placed on banks. Therefore, the experts were asked specifically whether or not the more rapidly spreading of COVID-19 altered their banking practices to a greater degree. In other words, this study investigates if the increase in the confirmed cases and morality rate of Covid-19 stimulated the bank managers to initiate more changes in meeting their customers' most current needs. The inclusion of COVID-19 as a distinct dimension allows the experts to rethink whether banks acted differently mainly due to the spreading of Covid-19 or as their normal course of action to improve service quality.

Considering that these experts may express similar ideas in different words, this study utilizes a Multi-Criteria Decision-Making (MCDM) approach, integrated with the fuzzy logic and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods, to determine the most influential criteria for wealth management banks during the COVID-19 pandemic. Our study differs from previous researches involving the fuzzy method in the design of the fuzzy linguistic scale. We develop a specific fuzzy linguistic scale for each expert to account for the wide variations in the experts' language expressions due to banks' varying cultures and practices. Hence, the extreme values derived from the fuzzy linguistic scale, which may represent important information from the experts, are not overlooked when calculating the crisp values to obtain the final causal relationships among the criteria.

The results of this study indicate that service quality is the most influential dimension, followed by customer relationships, bank performance, and COVID-19. In the dimension of service quality (D_2), customized investment information and innovation are the most critical criteria. In the dimension of customer relationship (D_3), switching behavior and the benefit of switching are the most important criteria. In the dimension of the banks' performance (D_1), fee income and customer satisfaction play a central role. In the dimension of COVID-19 (D_4), the number of confirmed cases in the top five countries has the highest influence.

This study contributes to the literature in three ways. Firstly, it is the first research to determine the most influential criteria affecting wealth management banks during the COVID-19 pandemic. Secondly, this paper improves the fuzzy-DEMATEL method by designing a specific linguistic scale for each expert to account for these wide variations in the language expressions used by the experts due to different cultures and histories. Thirdly, this study provides practical recommendations for bank managers to sustain their businesses during the ongoing COVID-19 crisis.

The remainder of this study is organized as follows: the second section reviews the relevant literature on the methods used to assess banking performance; the third section describes the research method and the sample; the fourth section presents the results; the fifth section discusses the results and implications; the sixth and final section concludes the paper.

2 Literature Review

This section describes the methods and criteria for the evaluation of bank performance. This section is divided into four sub-sections: 2.1 introduces the existing methods; 2.2 compares the existing methods with current ones; 2.3 details the criteria for evaluating bank performance; 2.4 explains the influence of the COVID-19 pandemic.

2.1 Existing Method

Previous studies used data envelopment analysis (DEA), and various MCDM, including AHP, grey relationship analysis (GRA), VIKOR, the Technique for Order of Preference by Similarity to Ideal Solutions (TOPSIS), DEMATEL, fuzzy-DEMATEL, and analytic network process (ANP), probabilistic linguistic TODIM (an acronym in Portuguese for interactive and multi-criteria decision-making), double hierarchy hesitant fuzzy linguistic entropy-based TODIM, and multi-attributive border approximation area comparison (MABAC) group decision-making method to evaluate alternatives [19, 21–34].

The DEA method compares the financial inputs of a decision-making unit (DMU) against its financial output to measure the efficiency of a process. Previous researchers [21, 25] applied the DEA method to measure the performance of banks. The results showed that FHC banks had higher efficiency than non-FHC ones.

Prior researchers adopted the AHP method to dissect a set of problems into a hierarchy of sub-problems for analysis [19, 22, 26]. The AHP computed the weight of each criterion and sub-criteria in a hierarchy. Wu, Lin, and Tsai [26] used AHP, GRA, and the Delphi method to evaluate Taiwanese wealth management banks based on the BSC factors. The AHP method determined the weights of the criteria. The GRA method analyzed both qualitative and quantitative relationships with insufficient information while the Delphi method [35] was used to obtain expert opinions.

Similarly, Stankeviciene and Mencaite [22] utilized AHP and GRA to evaluate Lithuanian bank performance based on BSC with 3 criteria (customer, financial, non-

financial) and 22 sub-criteria (customer accessibility, cash, support from shareholders, etc.) While AHP identified the weights between financial (customer and quantitative aspects such as customer accessibility, and cash) and non-financial (qualitative aspect such as support from shareholders), GRA established the hierarchical structure of interconnected decision elements encompassing criteria and sub-criteria. Subsequently, Ting [19] adopted AHP which revealed the criteria of "products" has the highest weight when evaluating Taiwanese wealth management banks.

Prior studies applied the VIKOR method proposed by Opricovic and Tzeng [36], which compares the alternative's "closeness" to the "ideal" alternative [36, 37]. Chang and Tsai [27] adopted a hybrid approach of AHP and VIKOR to evaluate the performance of seven Taiwanese wealth management banks based on bank experts. The VIKOR ranked the banking performance and explained the discrepancies among the seven banks.

The DEMATEL method, developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976, is a well-known MCDM technique used to solve complicated and intertwined problems [38, 39]. According to Tsai et al. [31], the previous studies on financial sector criteria had a disadvantage. Most studies assumed that the evaluation criteria are independent of one another and that there are no causal relationships among them. This assumption has restricted research on the understanding of a bank's performance. The DEMATEL method evaluates performance in the banking industry [23, 29, 40]. Li and Tzeng [40] emphasized that a hierarchical structure could improve the understanding of a cluster of intertwined problems and find workable solutions. This methodology examines the interdependence among the variables and produces graphs to reflect their interrelationships [23, 40, 41].

The fuzzy theory proposed by Zadeh [39] examines fuzzy linguistic terms. Zadeh [39] emphasized that the thinking, reasoning, and understanding of individuals are subjective and vague, and their thinking cannot be easily quantified using precise ratios or figures. Therefore, Zadeh [39] developed the fuzzy method to process human-centered problems with uncertainty and ambiguity in languages. Moreover, previous researchers [24, 33] extended the fuzzy method to analyze the vagueness in consumer and expert-language expressions. Furthermore, Liu and Cheng [34] improved the MABAC method to analyze ambiguous information from decision-makers.

Tsai et al. [31] and Dincer et al. [28] integrated the DEMATEL method and the fuzzy theory to investigate bank performance. Tsai et al. [31] applied the fuzzy-DEMATEL model. The DEMATEL method determines the degree to which the financial supervision criteria influence one another. The fuzzy method analyzes the vague language spoken by the financial supervisory experts. Based on the fuzzy method, the researchers converted the subjective views of the experts into numerical values between 0 and 1, de-fuzzified the values to calculate the average number, and then the crisp values. Finally, the researchers constructed the causal relationship among the criteria.

Puri and Yadav [30] and Nasseri et al. [42] applied the fuzzy Data Envelopment Analysis (DEA) to detect the cost and revenue efficiency of Indian banks.

Dincer et al. [28] integrated the fuzzy-DEMATEL, fuzzy-VIKOR, and fuzzy-TOPSIS to evaluate the innovation policies of the banks in Germany, France, Italy, England, and Spain. This study added the TOPSIS method to the DEMATEL and VIKOR methods. These researchers calculated the average fuzzy values derived from the expert opinions, proving that scope economics of inventions is most important. Shen et al. [43] used Multiple Rule-based Decision-Making (MRDM) and the fuzzy set technique to evaluate the performance of Taiwanese banks.

More recently, Lin, Wang, and Hung [32] integrated the DEMATEL, ANP, and structural equation modeling (SEM) methods to investigate the factors affecting consumers' intention to use online banking. The ANP method established the correlation among the factors of online banking usage and determined the weights of all factors. The main difference between AHP and ANP is that AHP treats all criteria as independent while ANP considers the interdependence among all criteria. The SEM method is a regression-based multi-variable technique that combines two statistical approaches: factor analysis and path analysis. The SEM method reconfirmed the results of DEMATEL and ANP.

Furthermore, Liu and Teng [24] applied an extended probabilistic linguistic TODIM method to evaluate alternative products based on online product reviews. This method determined the objective weights based on cross-entropy and entropy measures with probabilistic linguistic information. Liu et al. [33] adopted the double hierarchy hesitant fuzzy linguistic entropy-based TODIM approach to examine fuzzy linguistic terms. Liu and Cheng [34] improved the MABAC method and established a three-phase multi-attribute group decision-making (MAGDM) method to analyze the preference of decision-makers and to describe inconsistent and ambiguous information.

2.2 Comparison with Existing Methods

This section compares the fuzzy-DEMATEL method used in this study and other existing methods in the literature. The current study differs from other methods dealing with fuzzy terms in two ways. First, prior studies that applied

the fuzzy theory assumed that all experts have a similar degree of linguistic vagueness and that experts use similar words to express the same meaning. This assumption ignores the fact that financial institutions vary widely in history, culture, and policy. Consequently, the words and phrases spoken by experts from different banks may be highly diverse. For example, the state-owned banks with a longer history tend to be more conservative, thus the employees often use traditional expressions to describe their bank services. In contrast, private banks with a shorter history appear more aggressive. The managers of these banks are inclined to use modern words to explain their plans and actions. Realizing the differences in the language spoken and written by the experts from banks that vary considerably in culture, tradition, and mindset, this study designs a specific linguistic scale for each expert to measure his or her opinions. No two experts were given the same linguistic. We improve the existing fuzzy method to account for the large variations in experts' language expressions due to their different career backgrounds.

Second, previous studies used the average number of the same fuzzy scale given to all experts. Hence, prior researchers obtained the upper and lower limits from a single fuzzy scale and calculated the mean to consolidate the opinions from all the experts [28, 31]. These studies set the upper and lower bounds within a narrower range. In contrast, this study computes the upper and lower limits of the expert opinions derived from a set of specific fuzzy scales. Thus, the overall upper and lower limits include the extreme values from each fuzzy scale. Consequently, the uniqueness of the words associated with different banks is not ignored in the subsequent DEMATEL analysis. Unlike previous studies that used merely the average number of an identical fuzzy linguistic scale, the current study establishes the upper and lower bounds within a wider range, which allows for the existence of large differences in language expressions by experts who work at various banks.

In particular, this study used the grey theory proposed by Deng [44] to establish the fuzzy decision-making space. The grey theory describes a grey system in which partial information is known and the remaining information is unknown, thus defining the grey area. The grey theory does not define the best solution but provides the techniques for selecting a good solution when only partial information is available. During the COVID-19 period, the information and consequences of events are greatly uncertain. Therefore, this study uses the grey theory to construct the upper and lower bounds which include all the expert opinions because any of these inputs could possibly lead to an optimal solution. This study does not preclude any expert opinions because any of them may prove to be useful during the unprecedented period of COVID-19 without prior experiences.

This study then obtains the crisp values from a wider range of fuzzy values. Such improvement of the fuzzy-DEMATEL method helps process diverse expert views in the unprecedented COVID-19 challenge.

2.3 Evaluating Criteria for Bank Performance

A series of criteria can be found in extant literature to evaluate a bank's performance. Wu [26] determined the operational efficiency of Taiwanese financial holding companies using loans, operating revenue, deposits, the number of employees, the number of branches, and fixed capital. Prior researchers [27, 45, 46] examined wealth management banks, based on the financial criteria such as sales revenue, profits, market share, customers deposits, and bank assets.

A large body of literature measures bank performance using service quality [19, 23, 27, 47, 48]. Ang [48] examined the key factors driving the success of private wealth management banks and addressed a winning strategy. Ang [48] stressed the quality of service as the most important factor.

Chang and Tsai [27] and Ting [19] used the criteria of service quality (service attitude, consultancy, etc.) to evaluate the banks in Taiwan. Chang et al. [29] compared four banks in Taiwan based on financial services and customer perspective.

Benoit and Poel [49] claimed that company representatives that know each customer individually and offer him/her personalized service can increase their business and win their loyalty over time.

Phoon and Koh [50] emphasized the importance of innovations that enhance the way in which financial institutions serve their customers. They expounded that after the 2008 global financial crisis, the financial sector developed new technology to reach more customers and provide them with comprehensive knowledge about banking products and services. Buchak et al. [14] emphasized innovation in Fin-Tech.

Beaverstock et al. [51] and Jennings et al. [52] described the rise of the super-rich group, whose financial objectives are closely tied to the international financial system. These authors claimed that the affluent individuals, who enjoy private banking services, are likely to request that the banks include their family members in their financial plans because the rich intend to pass their wealth on to the next generation.

The multi-dimensional analysis of preference (LINMAP) is a popular method used by prior researchers to measure service quality. Zuo et al. [53] used the general multi-attribute multi-scale decision-making methods (MAMS) based on the dynamic linear programming technique for LINMAP to evaluate property perceived service

quality (PPSQ). The new method improves the traditional PPSQ evaluation process and provides an alternative solution for large scale data processing. Moreover, Zuo et al. [54] applied a large group decision-making (LGDM) method of generalized multi-attribute and multi-scale (MAMS) based on the linear programming technique for LINMAP. After integrating the large-scale heterogeneous data of expert preference and user evaluation, these researchers analyzed a set of survey data of PPSQ for the four public construction projects. The results confirmed the validity and rationality of the proposed new method, thus reinforcing the property service evaluation theory.

Lin et al. [32] found that bank managers could increase the customers' engagement of online banking to enhance their adherence to the Internet banking provider. Lu et al. [55] integrated DEMATEL, INRM, and DEMATEL-based ANP (DANP) to determine the user's intentions and behavior for mobile banking services in Taiwan. These authors found that trust is the key factor in deepening the relationship bond with banking customers.

Previous studies claimed that banks have striven to increase their fee income, which is a stable source of income [10, 56]. These studies found that customers who have high deposits with banks contribute more in fee income, which creates high costs when switching to other banks. The results of these studies suggest that banks that develop their fee-income services can 'lock-in' their customers. Abedifar et al. [57] argued that banks that provide higher benefits of switching can attract customers from other banks.

2.4 COVID-19

COVID-19 is a contagious disease that spreads from one person to another by means of close physical contact [1]. As of September 5, 2020, the confirmed cases worldwide reached 26,335,685 with 869,209 deaths [58]. As of September 5, 2020, the top five nations with the highest number of confirmed cases are the USA (6,150,655), Brazil (4,041,638), India (3,936,747), Russia (1,009,995), and Peru (670,145) [58].

Scientists can gauge the speed of one disease spreading through a population using the rate of transmission, also known as the basic reproduction number (R_0) [59]. This rate refers to the number of persons infected by a COVID-19 patient. An R_0 smaller than one (1) means that one COVID-19 patient passes the disease to less than one other person. An R_0 greater than one (1) indicates that the COVID-19 patient passes the disease to more than one individual [59].

The impact of COVID-19 on banking is enormous because, by their very nature, banks are vulnerable during economic downturns. Lagoard-Segot and Leoni [60] proposed a model that uncovers the increased likelihood of banks collapsing in developing countries, due to the prevalence of pandemics. COVID-19 is considered to be a "black swan" that produces a global impact, causing enormous losses in the global economy, financial markets, and institutions [61]. In March 2020, the U.S. stock market hit the circuit breaker mechanism four times in 10 days. The European and Asian stock markets also plunged. FTSE, the UK's main index fell by more than 10% on March 12, 2020, which has been the deepest drop since 1987. The Japanese stock market plummeted by more than 20% from its highest position in December 2019. Zhang et al. [62] reported that the COVID-19 pandemic has had a strong influence on the stock markets. The risk levels of all major countries, such as the USA, Italy, and Germany, increased substantially from February to March 2020. The sentiments of investors play an important role in causing the high volatility of the stock markets [62].

Based on the literature review, this study selects four dimensions for the analysis: bank performance (D_1), service quality (D_2), customer relationship (D_3), and COVID-19 (D_4). We also include 16 criteria (C_{11}-C_{15}, C_{21}-C_{23}, C_{31}-C_{35}, C_{41}-C_{43}) under the four dimensions, to identify the most influential criteria that affect wealth management banks during the COVID-19 pandemic. Table 1 contains the descriptions of the four dimensions and 16 criteria.

3 Methodology

This study utilizes the fuzzy-DEMATEL method that integrates the fuzzy logic and the DEMATEL methods to determine the influence of criteria. The fuzzy-DEMATEL method consists of four stages. Firstly, we apply the fuzzy theory to define the fuzzy decision-making space, which stems from individual use of vague linguistic terms to express their meanings. Secondly, we use the grey theory proposed by Deng [44] to establish the fuzzy decision-making space and to aggregate qualitative and independent expert opinions.

Thirdly, we adopt the DEMATEL method and use the de-fuzzifying approach to obtain crisp values. Fourth, and lastly, we construct an INRM, based on the prominence and relations of all dimensions and criteria. Figure 1 illustrates the four stages of the fuzzy-DEMATEL method.

3.1 First Stage: Define Fuzzy Decision-Making Space

The first stage includes two steps:

Step 1: Establish the direct-relation matrix $\boldsymbol{2\tilde{E}^o}$ based on crisp values.

Table 1 Dimensions and criteria for the evaluation of wealth management banks

Dimension/criteria		Description
D_1	*Key performance*	
C_{11}	Number of customers	Number of customers who receive wealth management services from banks
C_{12}	Customer asset	The total market value of the assets from wealth management customers at a particular bank
C_{13}	Fee income	Fee income collected by banks for providing financial products and services
C_{14}	Commission income	Commission earned by banks for selling insurance policies to wealth management customers
C_{15}	Customer satisfaction	The degree to which customers are pleased with the financial products and services offered by wealth management banks
D_2	*Service quality*	
C_{21}	Innovation	New and substantially improved financial products and services offered to wealth management customers
C_{22}	Customized investment information	A wide range of information for investment options provided to wealth management customers on a timely basis
C_{23}	Family financial planning	Financial planning based on the needs and objectives of the wealth management customers and their families
D_3	*Customer relationship*	
C_{31}	Customer engagement	The degree to which wealth management customers use bank products and services
C_{32}	Relationship bond	The propensity of customers to re-use or repurchase the financial products and services from the same bank
C_{33}	Benefit of switching	Perceived benefits received by customers for switching from the current bank to another bank
C_{34}	Cost of switching	Perceived costs incurred when customers switch from the current bank to another bank
C_{35}	Switching behavior	The likelihood that customers will turn the intention to switch into action
D_4	*COVID-19*	
C_{41}	Number of confirmed cases worldwide	The number of actual cases of COVID 19 worldwide
C_{42}	Number of Confirmed cases in the top five nations	The number of actual cases of COVID 19 in the top five nations affected
C_{43}	Taiwan rate of transmission	The number of persons infected by one COVID-19 patient

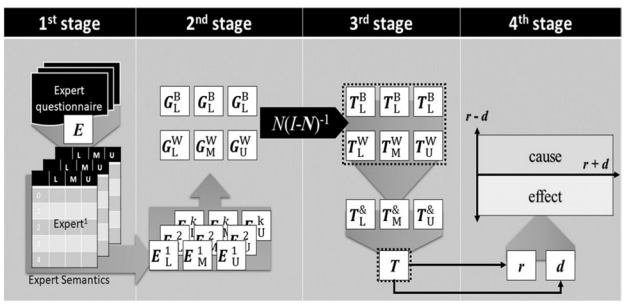

Fig. 1 The four stages of the fuzzy-DEMATEL method

Based on the interview data of K number of experts and the pairwise comparisons, the influences between criteria, can be obtained. The pairwise comparison scale may include five levels. Score "0" represents "no influence", "1" represents "very low" influence, "2" represents "low" influence, "3" represents "high" influence, and "4" represents "very high". The initial direct-relation matrix $\boldsymbol{2\tilde{E}^o}$ can be obtained using Eq. (1).

$$E^{\mathrm{o}} = \left[e_{ij}^{\mathrm{o}}\right]_{n\times n} \quad \text{for o} = 1, 2, \ldots, k \tag{1}$$

where k denotes the number of experts and n denotes the number of criteria.

$$E^{\mathrm{o}} = \left[e_{ij}^{\mathrm{o}}\right]_{n\times n} = \begin{bmatrix} e_{11}^{\mathrm{o}} & v & e_{1j}^{\mathrm{o}} & \ldots & e_{1n}^{\mathrm{o}} \\ v & & v & & v \\ e_{i1}^{\mathrm{o}} & v & e_{ij}^{\mathrm{o}} & v & e_{in}^{\mathrm{o}} \\ v & & v & & v \\ e_{n1}^{\mathrm{o}} & v & e_{nj}^{\mathrm{o}} & v & e_{nn}^{\mathrm{o}} \end{bmatrix}_{n\times n} \tag{2}$$

Step 2: Set a fuzzy linguistic scale.

We set a fuzzy linguistic scale for each expert after selecting the four dimensions and 16 criteria, we design a fuzzy linguistic scale to measure the true meanings of the experts' written and spoken words. Prior studies applied the same linguistic scale on every expert, based on the assumption that all individuals speak identical words to express the same meanings [31, 63, 64]. However, in the real world, experts in the field use different words and expressions to describe the same, or similar, meanings. Hence, this study sets a distinct linguistic scale for each expert. The degree of influence among the criteria is determined by a triangular fuzzy number, defined as a

Table 2 Fuzzy linguistic scale for each expert

Expert	Degree of influence					
	Score TFN	No 0	Very low 1	Low 2	High 3	Very high 4
a	L	0	20	40	60	80
	M	10	30	50	70	90
	U	20	40	60	80	100
	⋮	⋮	⋮	⋮	⋮	⋮

[a]Complete information available in Appendix Table 8

triplet (1, 2, 3). Table 2 exhibits the distinct fuzzy linguistic scale for each of the 10 experts.

3.2 Second Stage: Establish Fuzzy Decision-Making Space

This stage consists of two steps:

Step 1: Generate direct-relation fuzzy matrix.

We generate direct-relation fuzzy matrix $2\tilde{E}^{o}$ Based on the distinct linguistic scales for 10 experts, we construct a direct-relation fuzzy matrix using Eqs. (3–6).

$$2\tilde{E}^{o} = \left[e_{ij}^{o}\right]_{n\times n} = \left\{2\tilde{E}_{L}^{o}, 2\tilde{E}_{M}^{o}, 2\tilde{E}_{U}^{o}\right\} \tag{3}$$

where the subscripts L, M and U denote lower bound, middle bound, and upper bound, respectively.

$$2E_{L}^{o} = \left[e_{Lij}^{o}\right]_{n\times n} = \begin{bmatrix} e_{L11}^{o} & \cdots & e_{L1j}^{o} & \cdots & e_{L1n}^{o} \\ \vdots & & \vdots & & \vdots \\ e_{Li1}^{o} & \cdots & e_{Lij}^{o} & \cdots & e_{in}^{o} \\ \vdots & & \vdots & & \vdots \\ e_{Ln1}^{o} & \cdots & e_{Lnj}^{o} & \cdots & e_{Lnn}^{o} \end{bmatrix}_{n\times n} \tag{4}$$

$$\boldsymbol{2E_{M}^{o}} = \left[\boldsymbol{e_{Mij}^{o}}\right]_{n\times n} = \begin{bmatrix} \boldsymbol{e_{M11}^{o}} & \cdots & \boldsymbol{e_{M1j}^{o}} & \cdots & \boldsymbol{e_{M1n}^{o}} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{e_{Mi1}^{o}} & \cdots & \boldsymbol{e_{Mij}^{o}} & \cdots & \boldsymbol{e_{Min}^{o}} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{e_{Mn1}^{o}} & \cdots & \boldsymbol{e_{Mnj}^{o}} & \cdots & \boldsymbol{e_{Mnn}^{o}} \end{bmatrix}_{\boldsymbol{n\times n}} \tag{5}$$

$$\boldsymbol{2E_{U}^{o}} = \left[\boldsymbol{e_{Uij}^{o}}\right]_{\boldsymbol{n\times n}} = \begin{bmatrix} \boldsymbol{e_{U11}^{o}} & \cdots & \boldsymbol{e_{U1j}^{o}} & \cdots & \boldsymbol{e_{U1n}^{o}} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{e_{Ui1}^{o}} & \cdots & \boldsymbol{e_{Uij}^{o}} & \cdots & \boldsymbol{e_{Uin}^{o}} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{e_{Un1}^{o}} & \cdots & \boldsymbol{e_{Unj}^{o}} & \cdots & \boldsymbol{e_{Unn}^{o}} \end{bmatrix}_{\boldsymbol{n\times n}} \tag{6}$$

Step 2: Aggregate expert opinion.

Prior studies used the average number to indicate expert opinions [31, 63, 64] while ignoring extreme numbers, which may cause distortion of information. Therefore, this study applies the grey theory to construct the upper and lower bounds, so that the decision-process space is set within a wider range. The upper bounds of the direct-relation fuzzy matrix $\boldsymbol{2\tilde{G}^{W}}$ are obtained using Eqs. (7–10).

$$\boldsymbol{2\tilde{G}^{W}} = \left\{\boldsymbol{G_{L}^{W}}, \boldsymbol{G_{M}^{W}}, \boldsymbol{G_{U}^{W}}\right\} \tag{7}$$

$$\boldsymbol{G_{L}^{W}} = \max \boldsymbol{e_{Lij}^{o}} \tag{8}$$

$$\boldsymbol{G_{M}^{W}} = \max \boldsymbol{e_{Mij}^{o}} \tag{9}$$

$$\boldsymbol{G_{U}^{W}} = \max \boldsymbol{e_{Uij}^{o}} \tag{10}$$

The lower bounds of the direct-relation fuzzy matrix $\boldsymbol{2\tilde{G}^{B}}$ are derived using Eqs. (11–14).

$$\boldsymbol{2\tilde{G}^{B}} = \left\{\boldsymbol{G_{L}^{B}}, \boldsymbol{G_{M}^{B}}, \boldsymbol{G_{U}^{B}}\right\} \tag{11}$$

$$G_{L}^{B} = \min e_{L_{ij}}^{o} \tag{12}$$

$$\boldsymbol{G_{M}^{B}} = \min \boldsymbol{e_{M_{ij}}^{o}} \tag{13}$$

$$\boldsymbol{G_{U}^{B}} = \min \boldsymbol{e_{U_{ij}}^{o}} \tag{14}$$

3.3 Third Stage: Use the DEMATEL and Defuzzification Method

This stage comprises three steps:

Step 1: Calculate using DEMATEL.

We apply the DEMATEL method [65] on the upper bound $\boldsymbol{2\tilde{G}^{u}}$ and lower bounds $\boldsymbol{2\tilde{G}^{l}}$ of the direct-relation fuzzy matrix. The upper bounds $\boldsymbol{2\tilde{T}^{u}}$ and lower bounds $\boldsymbol{2\tilde{T}^{u}}$ of the total-relation fuzzy matrix can be obtained using Eqs. (15–17).

$$\boldsymbol{T} = \boldsymbol{N}(\boldsymbol{I} - \boldsymbol{N})^{-1} \tag{15}$$

where $\boldsymbol{I}$ denotes the identity matrix.

$$\boldsymbol{2\tilde{T}^{B}} = \left\{\boldsymbol{T_{L}^{B}}, \boldsymbol{T_{M}^{B}}, \boldsymbol{T_{U}^{B}}\right\} \tag{16}$$

$$\boldsymbol{2\tilde{T}^{W}} = \left\{\boldsymbol{T_{L}^{W}}, \boldsymbol{T_{M}^{W}}, \boldsymbol{T_{U}^{W}}\right\} \tag{17}$$

Step 2: Establish a single total-relation fuzzy matrix $\boldsymbol{2\tilde{T}^{\&}}$.

We de-fuzzify the upper bounds $\boldsymbol{2\tilde{T}^{W}}$ and lower bounds $\boldsymbol{2\tilde{T}^{B}}$ of the total-relation fuzzy matrix to generate a single total-relation fuzzy matrix $\boldsymbol{2\tilde{T}^{\&}}$ using Eqs. (18–21).

$$\boldsymbol{2\tilde{T}^{\&}} = \left\{\boldsymbol{T_{L}^{\&}}, \boldsymbol{T_{M}^{\&}}, \boldsymbol{T_{U}^{\&}}\right\} \tag{18}$$

$$T_{L}^{\&} = \left[t_{Lij}^{\&}\right]_{n\times n} = (t_{Lij}^{B} + t_{Lij}^{W})/2 \tag{19}$$

$$\boldsymbol{T_{M}^{\&}} = \left[t_{Mij}^{\&}\right]_{n\times n} = (t_{Mij}^{B} + t_{Mij}^{W})/2 \tag{20}$$

$$\boldsymbol{T}_U^{\&} = \left[t_{Uij}^{\&}\right]_{n\times n} = (t_{Uij}^{B} + t_{Uij}^{W})/2 \tag{21}$$

Step 3: Establish a crisp total-relation matrix.

During the last step, we obtain the total-relation matrix $\boldsymbol{T}$. We calculate the mean of the defuzzification value t_{ij} using Eqs. (22–23) below.

$$\boldsymbol{T} = \left[t_{ij}\right]_{n\times n} = \begin{bmatrix} t_{11} & v & t_{1j} & \ldots & t_{1n} \\ v & & v & & v \\ t_{i1} & v & t_{ij} & v & t_{in} \\ v & & v & & v \\ t_{n1} & v & t_{nj} & v & t_{nn} \end{bmatrix}_{n\times n} \tag{22}$$

$$t_{ij} = (t_{ij}^{L} + t_{ij}^{M} + t_{ij}^{U})/3 \tag{23}$$

3.4 Fourth Stage: Construct INRM

This stage includes two steps:

Step 1: Calculate the sum of the rows and columns.

The sum of the rows and columns in the total-relation matrix $\boldsymbol{T}$ is calculated, based on the degree of influence among the criteria. In Eq. 24, the sum of each row vector is denoted by $\boldsymbol{r}$, while in Eq. 25, the sum of each column vector is denoted by $\boldsymbol{d}$:

$$\boldsymbol{r} = (r_1, \ldots, r_i, \ldots, r_n)' = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \tag{24}$$

$$\boldsymbol{d} = (d_1, \ldots, d_j, \ldots, d_n)' = \left[\sum_{i=1}^{n} t_{ij}\right]'_{n\times 1} \tag{25}$$

In this study, r_i denotes the sum of the i-th row of matrix $\boldsymbol{T}$, and represents the sum of the direct and indirect effects of criterion i on other criteria. While d_j represents the sum of the j-th column of matrix $\boldsymbol{T}$, it also represents the sum of the direct and indirect influences of criterion j on other criteria.

Step 2: Establish the influential network relationship map.

When $i = j$, the $(r_i + d_i)$ value represents the degree of influence of each criterion. The $(r_i + d_i)$ value is known as prominence, which shows the degree of the central role played by this criterion in the system [34, 36, 66]. Conversely, the $(r_i - d_i)$ value represents the degree of influence received by criteria i from other criteria. A higher $(r_i - d_i)$ value means that criterion i has a stronger connection with the other criteria in the system. A higher $(r_i - d_i)$ value means that this criterion has a stronger influence on other criteria than the influence that is received from them [34, 36, 66, 67].

The sum $(r_i + d_i)$ can be used to determine the most influential dimension and criteria in each dimension. A larger value of $(r_i + d_i)$ indicates the higher influence that one criterion gives to, and receives from, other criteria. The smaller value of $(r_i + d_i)$ means the lower influence that one criterion gives to, and receives from, other criteria. We construct the INRM to depict the influential-relationship diagram for further analysis.

4 Results

This study uses the MCDM analytical tool, namely, the fuzzy-DEMATEL framework, to identify the criteria influencing the performance of wealth management banks during the COVID-19 pandemic. The prominence $(r_i + d_i)$ and net effects $(r_i - d_i)$ are derived from the total-relation matrix after the weights of the dimensions and criteria are determined. Figure 2 shows the INRM of the following four dimensions: bank performance, service quality, customer relationship, and COVID-19. Table 3 shows the degree of influence of the four dimensions (bank performance, service quality, customer relationship, COVID-19).

Based on the $(r_i + d_i)$ value in Table 3, service quality (D_2) has the highest prominence (19.626), followed by customer relationship (D_3; 19.235), bank performance (D_1; 18.369), and COVID-19 (D_4; 18.281). Based on the $(r_i - d_i)$ values, the criteria are divided into two groups of cause and effect. Customer relationship (D_3; 0.513) is the cause that influences the other three criteria. Bank performance (D_1), service quality (D_2), and COVID-19 (D_4; -0.298) are affected by the other criteria.

4.1 Bank Performance (D_1)

The dimension of bank performance (D_1) consists of five criteria: the number of customers, customer assets, fee income, commission income, and customer satisfaction. Figure 3 shows the INRM of the five criteria within bank performance (D_1). Table 4 shows the degree of influence among the five criteria in D_1.

Based on the $(r_i + d_i)$ values presented in Table 4, their prominence is ranked in the order of fee income (C_3; 27.219), customer satisfaction (C_5; 27.122), the number of customers (C_1; 27.033), commission income (C_4; 26.666), and customer assets (C_2; 25.778). Based on the $(r_i - d_i)$ values, the net effects are ranked in order of the number of customers (C_1; 0.494), customer satisfaction (C_5; 0.469), fee income (C_3; 0.386), customer assets (C_2; -0.352), and commission income (C_4; -0.997). The number of customers (C_1), fee income (C_3), and customer satisfaction (C_5) are the causes, while customer assets (C_2) and commission income (C_4) are the effects.

4.2 Dimension of Service Quality (D_2)

The dimension of service quality (D_2) encompasses three criteria, namely, innovation, timely investment information, and family financial planning. Figure 4 depicts the

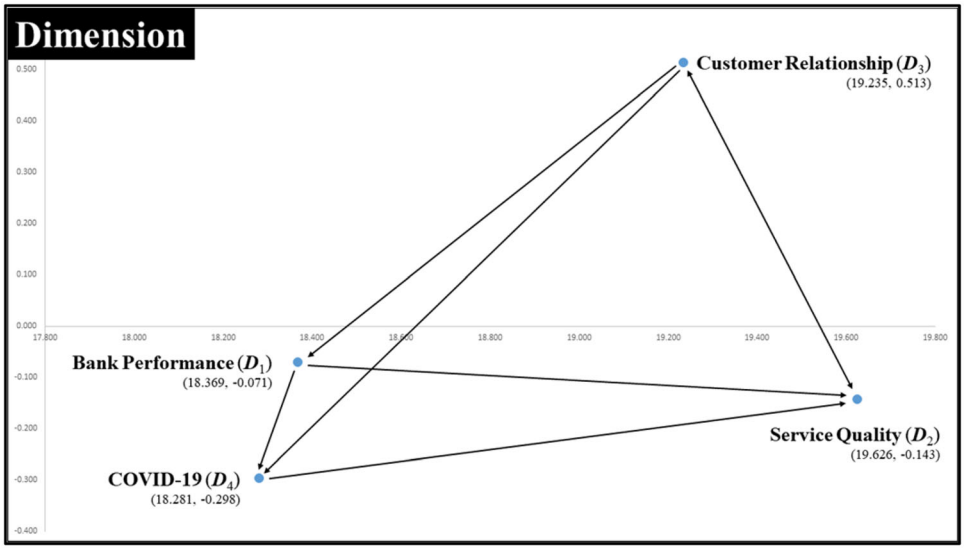

Fig. 2 INRM of the four dimensions

Table 3 The degree of influence among the four dimensions

	D_1	D_2	D_3	D_4	r_i	d_i
D_1	2.172	2.426	2.217	2.334	9.149	9.220
D_2	2.328	2.425	2.684	2.305	9.742	9.885
D_3	2.430	2.682	2.321	2.440	9.874	9.361
D_4	2.290	2.351	2.140	2.211	8.992	9.290

INRM of the three criteria in service quality (D_2). Table 5 shows the degree of influence among the three criteria in D_2.

Based on the $(r_i + d_i)$ values presented in Table 5, their prominence is ranked in the order of customized investment information (C_7; 139.256), innovation (C_6; 139.199), and family financial planning (C_8; 138.833). Based on the $(r_i - d_i)$ values in Table 5, the net effects are ranked in

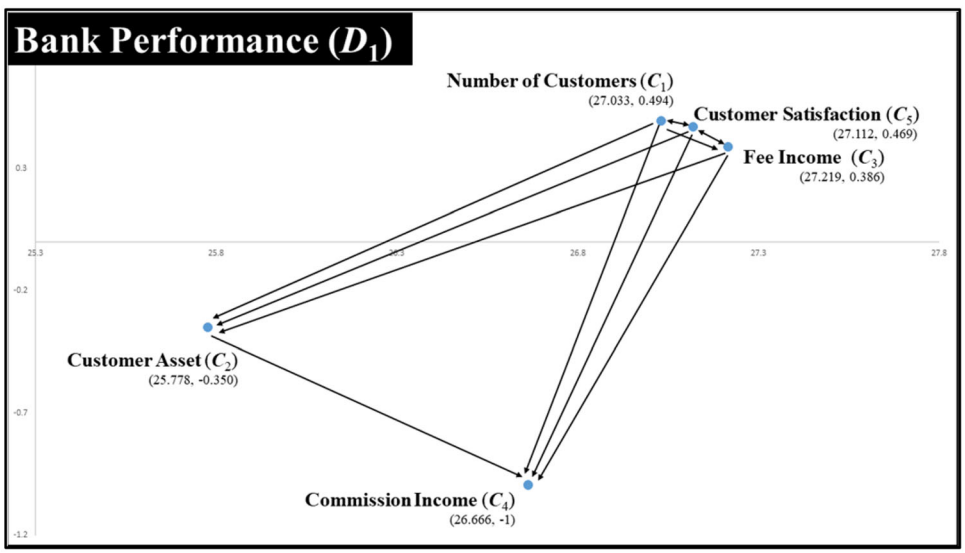

Fig. 3 INRM of the five criteria within bank performance (D_1)

Table 4 The degree of influence among the criteria in bank performance (D_1)

	C_1	C_2	C_3	C_4	C_5	r_i	d_i
C_1	2.612	2.700	2.800	2.893	2.758	13.763	13.27
C_2	2.572	2.391	2.529	2.643	2.579	12.713	13.065
C_3	2.755	2.715	2.655	2.866	2.811	13.803	13.416
C_4	2.556	2.562	2.623	2.521	2.571	12.834	13.831
C_5	2.774	2.697	2.809	2.908	2.607	13.795	13.326

Table 5 The degree of influence among the criteria in service quality (D_2)

	C_6	C_7	C_9	r_i	d_i
C_6	23.040	23.585	23.278	69.903	69.296
C_7	23.125	23.045	23.123	69.293	69.963
C_8	23.131	23.333	22.984	69.449	69.385

order of innovation (C_6; 0.606), family financial planning (C_8; 0.064), and customized investment information (C_7; -0.670). Innovation (C_6) and family financial planning (C_8) are the causes, while customized investment information (C_7) is the effect.

4.3 Customer Relationship (D_3)

The dimension of customer relationship consists of five criteria: customer engagement, relationship bond, the benefit of switching, the cost of switching, and switching behavior. Figure 5 depicts the INRM of the five criteria in customer relationship (D_3). Table 6 reports the degree of influence among the five criterion in D_3.

Based on the $(r_i + d_i)$ values presented in Table 6, their prominence is ranked in the order of switching behavior (C_{13}; 15.583), the benefit of switching (C_{11}; 15.443), customer engagement (C_9; 14.541), relationship bond (C_{10}; 13.483), and the cost of switching (C_{12}; 12.472). Based on the $(r_i + d_i)$ values, the net effects are ranked in the order of the benefit of switching (C_{11}; 0.709), customer engagement (C_9; 0.583), relationship bond (C_{10}; -0.137), switching behavior (C_{13}; -0.147), and the cost of switching (C_{12}; -1.008). Customer engagement (C_9) and the benefit of switching (C_{11}) are the causes, while the relationship bond (C_{10}), the cost of switching (C_{12}), and switching behavior (C_{13}) are the effects.

4.4 COVID-19 (D_4)

The COVID-19 dimension includes three criteria, namely, the number of confirmed cases worldwide, the number of confirmed cases in the top five nations, and the Taiwanese rate of transmission. Figure 6 depicts the INRM of the three criteria in COVID-19 (D_4). Table 7 includes the degree of influence among the three criteria in D_4.

Based on the $(r_i + d_i)$ values presented in Table 7, their prominence is ranked in the order of number of confirmed cases in the top five nations (C_{15}; 26.773), the number of confirmed cases worldwide (C_{14}; 25.529), and the Taiwanese rate of transmission (C_{16}; 24.259). Based on the $(r_i - d_i)$ value in Table 7, the net effects are ranked in the order of the number of confirmed cases in the top five nations (C_{15}; 0.198), the Taiwanese rate of transmission (C_{16}; 0.111), and the number of confirmed cases worldwide (C_{14}; -0.309). The number of confirmed cases in the top

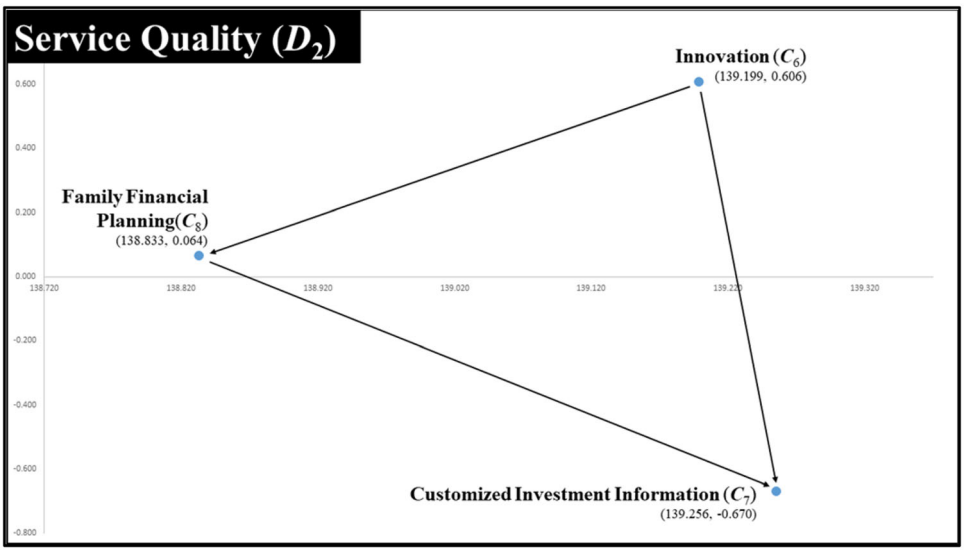

Fig. 4 INRM of the three criteria in service quality (D_2)

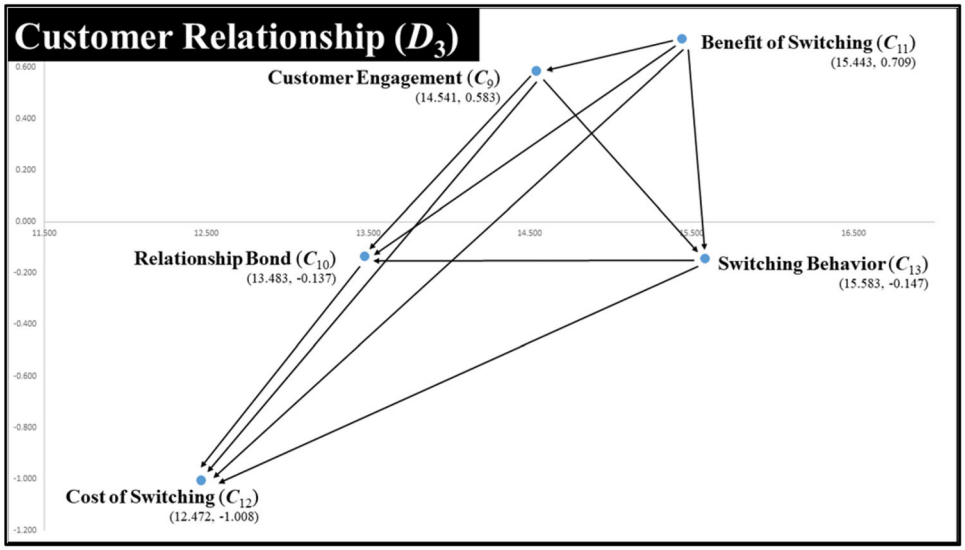

Fig. 5 INRM of the five criteria in customer relationship (D_3)

Table 6 The degree of influence among the criteria in customer relationship (D_3)

	C_9	C_{10}	C_{11}	C_{12}	C_{13}	r_i	d_i
C_9	1.356	1.442	1.624	1.422	1.720	7.562	6.979
C_{10}	1.342	1.214	1.377	1.272	1.468	6.673	6.810
C_{11}	1.635	1.518	1.536	1.513	1.874	8.076	7.367
C_{12}	1.130	1.152	1.171	1.033	1.246	5.732	6.740
C_{13}	1.516	1.484	1.660	1.500	1.557	*7.718*	7.865

Table 7 The degree of influence among the criteria in COVID-19 (D_4)

	C_{14}	C_{15}	C_{16}	r_i	d_i
C_{14}	4.084	4.521	4.005	12.610	12.919
C_{15}	4.681	4.489	4.315	13.485	13.287
C_{16}	4.154	4.277	3.753	12.185	12.074

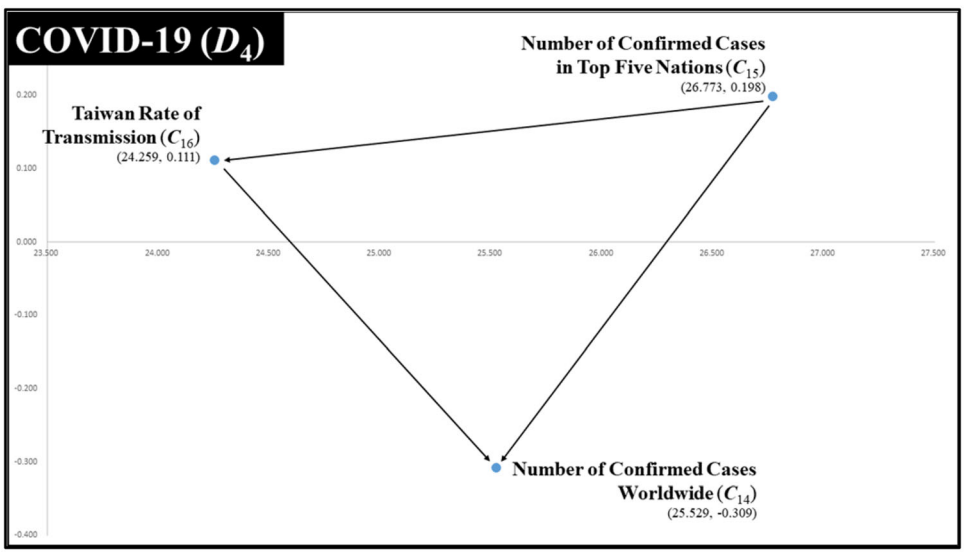

Fig. 6 INRM of the three criteria in COVID-19 (D_4)

five nations (C_{15}) and the Taiwanese rate of transmission (C_{16}) are the causes, while the number of confirmed cases worldwide (C_{14}) is the effect.

4.5 Discussion and Implications

This study applied the fuzzy-DEMATEL approach to identify the most critical criteria affecting the Taiwanese wealth management banks during the COVID-19 period. Based on the literature review, we selected four dimensions and 16 criteria to investigate their degree of influence. We calculated the weight of four dimensions and 16 criteria, determined the degree of influence of the dimensions and criteria, and finally, ranked the criteria.

5 Discussion

Based on the empirical results, we found that among the four dimensions of bank performance, service quality, customer relationship, and COVID-19, service quality (D_2) has the highest influence ($\boldsymbol{r}_i+\boldsymbol{d}_i$ = 19.626), which means that it plays a central role among the four dimensions. In the dimension of bank performance (D_1), fee income (C_3) has the highest influence ($\boldsymbol{r}_i+\boldsymbol{d}_i$ = 27.219). In the dimension of service quality (D_2), customized investment information (C_7) has the greatest influence ($\boldsymbol{r}_i+\boldsymbol{d}_i$ = 139.256). In the dimension of customer relationship (D_3), cost of switching (C_{13}) is the most influential criteria ($\boldsymbol{r}_i+\boldsymbol{d}_i$ 15.583) among the five criteria. In the dimension COVID-19 (D_4), the number of confirmed cases in the top five nations (C_{15}) has the highest influence ($\boldsymbol{r}_i+\boldsymbol{d}_i$ = 26.773).

Service quality (D_2) has the highest influence among the four dimensions. This result is consistent with the previous studies that used BSC to measure bank performance and found that the customers' perception of the bank services plays a crucial role [19, 21, 27]. Service quality is especially important for wealth management banks because these banks serve affluent customers, who usually hold higher expectations for the services they receive [48]. In general, service quality includes the wealth managers' service attitude, their communication skills, and the provision of relevant information suited for a particular customer's needs [19]. Customer relationship is the major cause. This finding is consistent with the literature [32, 55] that deepening the relationship with customers tends to increase their loyalty with the service providers. Overall, the results of this study reveal a similarity between the 2008 global crisis and the 2019–2020 COVID-19 pandemic. Higher bank service quality can always retain customers and increase customer satisfaction, regardless of the financial turbulence.

Fee income (C_3) has the highest influence in the dimension of bank performance (D_1). This outcome is consistent with previous studies, which stated that banks started to focus on fee income after the 2008 global financial crisis because it is stable and unaffected by the credit risk [10, 54]. As one bank expert mentioned, "Wealth management customers contribute greatly to the bank's fee income simply because of their high deposit, which is an investable asset." The empirical evidence suggests that fee income is, indeed, the most critical criterion that affects the number of customers, customer assets, and customer satisfaction. The number of customers (C_1) and customer satisfaction (C_5) are the major causes.

Customized investment information (C_7) is the most influential criterion in the dimension of service quality (D_2). This result is consistent with the studies by Benoit and Poel [49] and Schröder [20] that claim that wealth managers who know their customers individually and offer them customized services are more likely to win their businesses. One bank expert stated that "wealth management customers are concerned about the bank managers' abilities to recommend asset allocations, based on their individual needs and objectives, in a timely matter." The empirical evidence indicates that customized investment information reflects service quality the most, and it affects the banks' attitude towards launching innovative products and services for individual customers and their family members.

Switching behavior (C_{13}) is the most influential criterion in the dimension of customer relationships (D_3). This is consistent with Abedifar et al. [57] and Yin and Matthews [56], who discovered that when customers use bank products and services frequently, they incur higher switching costs, resulting in lower switching behavior. One bank expert expressed, "Wealth management customers, who are highly involved in bank services, adhere more to the banks. Thus, it is harder for them to switch banks". The empirical evidence suggests that switching behavior is highly connected to the cost/benefit of switching, customer engagement, and the relationship bond.

Covid-19 has the least impact on the changing practices of the banks. The number of confirmed cases in the top five nations (C_{15}) is the most influential criterion in the dimension of COVID-19 (D_4). This result is consistent with the study of Lagoard-Segot and Leoni [60] that described the impact of COVID-19 on the major economies, such as the USA and Italy. The results of this study indicate that the nations most affected by COVID-19, such as the USA, Italy, and Brazil, greatly influence the global economy and financial markets. Hence, Taiwanese financial institutions must react quickly to the changing environment and strive to maintain the quality of their services to their wealth management customers. One bank expert mentioned, "The

COVID-19 crisis forces the banks to create contactless solutions to help their customers protect and to grow their assets. The contactless services include the heavy use of online banking, mobile banking, and short text messages." The empirical evidence indicates that the increase of confirmed COVID-19 cases in major economies arouses the attention of wealth management banks so that they search for new ways to serve their customers.

5.1 Managerial Implications

The results of this study provide practical managerial implications for bank managers and other decision-makers who intend to improve their service performance, following the COVID-19 pandemic. Based on the weights and prominence of the four dimensions (bank performance, service quality, customer relationships, and COVID-19), we found that service quality is the most important dimension, followed by customer relationship. The most influential criteria include fee income, customized investment information, switching behavior, and the number of confirmed cases in the top five nations.

The findings of this study indicate that banks should focus on improving their service quality and customer relationships, in order to attract and retain customers during COVID-19. Banks could gain a better understanding of their individual customers and their family members, thus providing customized services, and encouraging the customers to use their products and services more frequently. Banks may also differentiate their services for wealth management customers than for regular customers by offering higher discounts and more investment or hedging products. For example, banks could provide private consultations, visit their homes and offices without asking customers to go to the banks, reserve private VIP parking spaces, and assure their customers of confidentiality. These practices may enhance the banks' service quality and win the trust of their customers.

The empirical results suggest that fee income is the most influential criterion in the dimension of bank performance. Banks should focus on generating a non-interest fee income to increase customer satisfaction, the number of customers, customer assets, and commission income from selling insurance. The bank fee-income products include the trading of stocks, mutual funds, Exchange-Traded Funds (ETFs), trust accounts, estate planning, off-share banking. Banks could develop a wide range of products and services to meet the needs of high-net-worth customers who often conduct international business and who need to manage their money globally. The provision of a variety of fee-income products and services enables wealth management banks to maintain a higher number of customers with greater assets under bank management and with greater satisfaction. At the same time, the various products and services allow customers to contribute an increased portion of fee income to the banks.

The outcome of this study reveals that customized investment information is most important in the banks' services. The bank managers must be aware of the needs of the high-net-worth individuals who typically desire to maintain a high standard of living and to sustain their wealth across multiple generations. Banks must assist high-net-worth individuals and families to achieve such objectives through careful financial planning. For example, wealth management customers are probably concerned about tax shields, estate planning, planning for business succession, avoiding losses from exchange rate fluctuations, and easy access to offshore assets. In addition, innovation is the second-most influential criterion, with a high prominence value close to that of customized investment information. This outcome implies that innovative products and services tend to serve customers satisfactorily. Therefore, banks may develop innovative products and services, such as using robotic financial advisors for suggesting investment portfolios, as well as sending timely notices to customers for buying and selling stocks and mutual funds through the Internet or mobile phone. This practice would provide a "contactless" service system, which is critically needed during the COVID-19 period.

In addition, switching behavior has the highest influence, closely followed by the benefit of switching, in the dimension of customer relationships. Banks could monitor the customers' behavior about switching banks. Banks may endeavor to maintain the current customers and offer greater benefits to attract them away from other banks. Banks could maintain their current customers by motivating them to use more banking products and services, thus deepening their relationship with them. Banks may also solicit individuals to switch to their banks by offering greater benefits, such as lower bank service charges and more products that are suited to affluent customers.

Moreover, we find that the top nations affected by COVID-19 are the most influential criteria in the dimension of COVID-19. These nations include the major economies of the world, which have caused volatility in the financial markets. This outcome suggests that wealth management banks should closely monitor the increased fluctuations of the financial markets (i.e., stocks, bonds, foreign exchange, commodities) and analyze the ways in which customers' assets are affected by changes in the market. Banks could provide solutions to their customers in response to the global changes that are brought about by the COVID-19 pandemic. For example, banks could advise their customers to invest their excess funds in bonds, rather than certificates of deposit, given the lowering of interest rate worldwide.

Hence, this study gives bank practitioners, who provide wealth management services, with criteria that are most critical to a bank's success during the COVID-19 period. In short, bank managers may focus on the most influential

dimensions and criteria and analyze the ways in which COVID-19 affects the assets of their high-net-worth customers. Formulating appropriate service strategies is essential for bank decision-makers to sustain and grow bank businesses in response to the threat of COVID-19.

6 Conclusions

We proposed an improved fuzzy-DEMATEL method [68, 69] to analyze the interactive relations among four dimensions and 16 criteria, and to identify those that have been the most influential in affecting the performance of wealth management banks during the 2019–2020 COVID-19 period. This study collected the opinions of the 10 anonymous experts in the banking industry utilizing surveys and interviews. Their opinions provided valuable insights into the understanding of how banks have responded to the negative effect of COVID-19 during 2019 and 2020.

By integrating all the literature reviews, we selected the following four dimensions and 16 criteria: bank performance (the number of customers, customer asset, fee income, commission income, customer satisfaction), service quality (innovation, customized investment information, family financial planning), customer relationship (customer engagement, relationship bond, the benefit of switching, the cost of switching, switching behavior), and COVID-19 (the number of confirmed cases worldwide, the number of confirmed cases in the top five nations, the Taiwanese rate of transmission). We improved the fuzzy-DEMATEL method by designing a specific fuzzy linguistic scale for each of the 10 experts who vary largely in the language expressions. We then ranked the criteria according to their influence on one another.

The empirical results of this study can be summarized as follows: Firstly, the order of influence of the four dimensions is service quality (D_2), customer relationship (D_3), bank performance (D_1), and COVID-19 (D_4). This result is consistent with the literature of Ang [48], Chang and Tsai [27], Ting [19], and Wu et al. [26], who claimed that a high service quality may retain customers in a financial crisis.

Secondly, the most influential criteria are identified within the four dimensions. In the dimension of service quality, customized investment information and innovation are the most influential criteria. In the dimension of customer relationship, switching behavior and the benefits of switching are the most important criteria. In the dimension of bank performance, fee income and customer satisfaction are the most critical criteria, and in the dimension of COVID-19, the number of confirmed cases in the top five nations is the most influential criterion.

The empirical results provide practical managerial implications for bank managers. Bank leaders should focus on improving service quality and customer relationships to sustain their business, despite the negative effects of COVID-19. Bank decision-makers may strive to provide customized investment information in a timely matter and use innovative and digital ways, such as online and mobile banking system to communicate with their customers. Bank managers could increase customer usage of their products and services to prevent them from switching to other banks. At the same time, bank managers could attempt to increase fee income by providing a wide range of financial products and services and enlarging the number of customers. Finally, bank practitioners must watch the changes in the financial markets closely, due to COVID-19, and offer individualized solutions to sustain their customers' high asset values during such a volatile period. Overall, banks that protect their customers' assets by responding quickly to the changing financial markets are likely to excel during COVID-19.

This study contributes to the literature because it is the first to apply the fuzzy-DEMATEL method to evaluate wealth management banks during the COVID-19 period. The results of this study benefit bank management by improving the service quality of wealth management banks. The findings also assist customers in selecting banks that provide high- quality services.

Although our study contributes to the success factors of wealth management banks during the COVID-19 pandemic, it still has its limitations. We have only studied some Taiwanese banks; therefore, the results probably cannot be generalized widely. Although the criteria are selected, based on the work of a large number of academic researchers, other important factors and features may have been overlooked. Future research may compare bank performance before, during, and after the COVID-19 period to investigate the evolution of banking services over these years.

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Declarations

Conflict of interest The authors declare no conflict of interest.

Appendix

See Table 8.

Table 8 Fuzzy linguistic scale for each expert

E		0	1	2	3	4	E		0	1	2	3	4
1	L	0	20	40	60	80	6	L	0	20	40	60	80
	M	10	30	50	70	90		M	10	30	50	70	90
	U	20	40	60	80	100		U	20	40	60	80	100
2	L	10	20	40	60	90	7	L	0	41	51	61	81
	M	15	30	50	75	95		M	20	45.5	55.5	70.5	90.5
	U	20	40	60	90	100		U	40	50	60	80	100
3	L	0	10	40	70	90	8	L	0	41	61	71	81
	M	0	20	50	75	95		M	20	50.5	65.5	75.5	90.5
	U	0	30	60	80	100		U	40	60	70	80	100
4	L	0	10	30	60	80	9	L	0	21	41	61	81
	M	5	20	45	70	90		M	10	30.5	50.5	70.5	90.5
	U	10	30	60	80	100		U	20	40	60	80	100
5	L	0	10	25	50	80	10	L	0	21	41	61	81
	M	5	17.5	37.5	65	90		M	10	30.5	50.5	70.5	90.5
	U	10	25	50	80	100		U	20	40	60	80	100

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