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AHP MODEL ON THE ASSESSMENT OF TECHNOLOGICAL INNOVATION IN BANKING SECTOR (WITH REFERENCE TO INDIAN AND FOREIGN BANKS)

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Abstract: The banking system's efficient and stable performance is the foundation of any economy's long-term growth. Several economic reforms have recently been initiated in India in order to facilitate growth and to withstand the dynamics of the global economy. In this context, the current study compares the performance of selected Indian and foreign banks in India over a time horizon to detect any changes in performance over time. First, the selected banks' performance is evaluated in terms of management efficiency using a Multi-Criteria Decision Making (MCDM) technique for determining criteria weight. The study also employs a fuzzy logic model to ensure the consistency of performance-based ranking on technological innovation-related parameters. The main goal of this study is to develop an Analytic Hierarchy Process (AHP) to perform the best in the digital marketplace and this helps customers in the selection of proper banks so that the main goal of all banks is to retain their customers and improve their performance in terms of capital appreciation. To achieve the study's goal, criteria and their sub-criteria are determined through an extensive literature review, and a structured questionnaire is prepared to collect data from experts via a personal interview on a scale of 1 to 5. Analytic Hierarchy Process (AHP), a multi-criteria decision making mathematical tool, was used to analyse the importance of each criteria and develop a hierarchy of importance criteria. According to the weight estimated using fuzzy logic of geometric mean, the most important criterion is 'customised services,' followed by 'competitiveness,' 'cost effectiveness,' 'efficiency,' and 'reduction in client influx.' Banks should prioritise these critical criteria in order to improve the quality of their e-services, consumer satisfaction and retention, and online reputation. Customers are increasingly interacting with web-based applications as the internet and web applications proliferate. They are shifting from offline to online, creating a difficult environment for service providers, particularly those in the banking sector, to meet their specific needs. It is thus necessary not only to identify the critical factors influencing bank performance, but also to prioritise them.

Keywords: multi-criteria decision model, customized services, cost effectiveness, efficiency, competitiveness and reduction in client influx.

I. INTRODUCTION

Banks play an important role in any economy. Stability in the banking system and long-term performance of banks not only ensures optimal use of financial resources, but also ensures effective financial flow across the economy's components. As a result, banks play an important role in any country's economic growth and inclusive development. Since the early 1990s, the Indian economy has undergone continuous reform and structural changes. Along with the rest of the world, the economy has undergone several changes. Recent events, such as the bankruptcy of Lehman Brothers in 2008, which triggered the global economic crisis, Brexit, the devaluation of the yuan, the Greece debt crisis, an increase in US debt, a slump in the Japanese economy due to natural calamity, and the ongoing war on terrorism, to name a few, have all had a significant impact on the global economy. In the last few years, India has seen major reforms such as demonetization, the emergence of the digital economy, and GST. The banking sector in India is primarily divided into two types of ownership groups: public and private (Domestic and Foreign). Although recent studies on credit, market, and liquidity risk have highlighted the resilient nature of the Indian banking system due to its inherent system to withstand global economic turbulence, it is critical to study bank performance to ensure sustained profitability while minimising risk. As a result, this field has always piqued the interest of researchers and practitioners. Furthermore, because India is growing at a rapid pace, a comparative study of Indian sector and foreign sector banks in India is required. In the twenty-first century, the younger generation is becoming more interested in joining the digital world. People are emerging and becoming acquainted with the internet and its services. In November 2013, India had approximately 205 million internet users, with broadband connectivity increasing at a rate of 40%. (Chakravarti, 2013). The more people who have access to the internet, the greater the potential for online.

Because of information technology and the internet, any product's information is only a click away. Every month, a new product or technology is introduced. Technology is rapidly evolving. The success of online services is entirely dependent on a thorough understanding of customer characteristics such as needs, purchasing patterns, influencing criteria, and priorities (Kumar & Dash, 2014). Customers who shop online are more aware, and they have more options than those who shop in person. Attracting, engaging, and convincing them to buy, and retaining customers are the most difficult tasks for online service providers. It is thus necessary not only to determine what is important, but also to prioritise the factors that influence customers to use online banking services. The study creates a Hierarchy Structural Model (HSM) of consumer decision making in the digital marketplace based on the importance of the identified criteria.

However, it is worth noting that Multi-Criteria Decision Making (MCDM) approaches have emerged as a growing stream of literature that has been used by several researchers to evaluate bank performance (Douplos & Zopounidis, 2015). MCDM techniques are commonly used to solve complex economic decision-making problems and to improve the robustness of financial analysis (Balzentis et al., 2012). The literature abounds with applications of various MCDM methods and techniques for understanding and ranking bank performance.

Saaty's (1980) AHP integrates expert opinions and evaluation scores into a simple elementary hierarchy system by decomposing complex problems from higher hierarchies to lower ones. Yahya and Kingsman (1999) were among the first researchers to use AHP to determine priorities in supplier selection. Analytic Network Process (ANP) is a multi-attribute decision-making approach that allows the transformation of qualitative values to quantitative ones. Because AHP is a subset of ANP and lacks feedback loops among the factors, ANP is used to determine supplier selection over the long term (Kara and Işık (2009).

This study has identified five criteria, which influence the performance of selected banks in the assessment of technological advancement. The five criteria are:

1. Customized services
2. Competitiveness
3. Cost effectiveness
4. Efficiency
5. Reduction in Client Influx

II. LITERATURE REVIEW

However, because the uncertainty and ambiguity of the experts' opinions is a prominent feature of the problem, this impreciseness of human judgments can be addressed using Zadeh's fuzzy sets theory (1965). The Fuzzy AHP method (Cheng, 1997) uses fuzzy set theory and hierarchical structure analysis to systematically solve the selection problem. Essentially, the Fuzzy AHP method represents the elaboration of a standard AHP method into a fuzzy domain by calculating with fuzzy numbers rather than real numbers (Petkovic, 2012). On the other hand, because ANP only deals with sharp comparison ratios, Fuzzy ANP can deal with uncertain human judgments because the weights are easier to calculate than in conventional ANP (nüt, S., Kara, S.S., and Işık, E, 2009). When dealing with a large number of pairwise comparisons, ANP, AHP, FAHP, or FANP can become difficult to manage. TOPSIS, a widely used multi-attribute decision-making tool, can be used instead (Hwang and Yoon, 1981). According to TOPSIS, the most preferred alternative should not only be the shortest distance from the positive ideal solution, but also the farthest distance from the negative ideal solution. Chen et al. (2006) used fuzzy linguistic values to extend the TOPSIS concept to fuzzy environments. This fuzzy TOPSIS method corresponds to human thinking in the real world.

Agarwal and Prasad (1998) investigated people's willingness to use new technology. Personal Innovativeness in the domain of Information Technology was defined by Keisidou, Sarigiannidis, and Maditinos (2011) as "the degree to which one is willing to use modern technology over his peer group." Customers will adopt technology more quickly and perceive it to be more useful if they are having fun with it (Cheng, 2011). Although Indian e-commerce is not a new concept, and there are more opportunities to do business on this new platform, it is still an untapped market. However, due to the increased penetration of IT and the internet, information is flowing at a rapid pace. Every day, we are surrounded by something innovative. Because the world is changing so quickly, one new technology becomes obsolete in a matter of months. Customers must be aware of these technologies and be willing to try them out. According to the survey, nearly 90% of online customers are under the age of 30. (Sheth, 2013). The reason for this is that they are aware of new technology and want to be innovative (Sheth, 2013).

Employees can also become acquainted with uncertainty and develop a more positive attitude toward acceptance, and it has been demonstrated that high levels of Personal Innovativeness in the domain of Information Technology influence customers' attitudes toward online purchasing. Technology adoption demonstrates your eagerness to use and become acquainted with new technology (Rogers, 2010). We now have many online shopping websites that offer mobile apps and allow customers to purchase through the apps. Personal Innovativeness in the domain of Information Technology has a positive impact on wireless internet services via mobile technology, according to Lu, Yao, and Yu (2005). As the demand for such applications grows, many organisations are investing large sums of money in this area (Lu et al., 2005). The ability to use computers and new technology is reflected in one's self-efficacy. Though it is expected that one has knowledge of a specific product, hesitation arises when making a purchase decision. According to the study, peer group or senior advice provides a positive push toward a final decision (Kumar & Dash, 2014).

Although F-AHP has many applications in various fields such as personnel selection, weapon selection, energy alternatives selection, job selection, and performance evaluation systems (Kilic, H.S.,2011), only the most recent Fuzzy AHP applications for supplier selection problems will be discussed in the following paragraphs. In electronic marketplaces in 2010, a Fuzzy AHP method is used for supplier selection (Chamodrakas, Batis, and Martakos, 2010). According to their two-phase methodology, the first phase involves initial screening of suppliers via the imposition of hard constraints on the selection criteria. In the second phase, final supplier evaluation is carried out using a modified variant of Fuzzy AHP. This methodology makes it easier to elicit user preferences by reducing the amount of user input required (i.e. pair-wise comparisons) and decreasing computational complexity.

In 2011, the Fuzzy AHP approach was used to select suppliers in a washing machine company (Kilinci & Onal, 2011). (2011). First, they determine the criteria that provide the highest level of customer satisfaction and design the hierarchy structure for supplier selection, which includes the main attributes and sub-attributes. Pair-wise comparison matrices are used to calculate the weights of the attributes and alternatives. In 2012, the best supplier for developing a low-carbon supply chain is chosen using a combination of fuzzy AHP and fuzzy objective linear programming (Shaw et al, 2012). Initially, Fuzzy AHP is used to determine the weights of predetermined criteria such as cost, quality, rejection percentage, late delivery percentage, greenhouse gas emissions, and demand. The best supplier is then determined using fuzzy objective linear programming.

In 2013, an interactive solution approach for multiple objective supplier selection problems using Fuzzy AHP is proposed (Arikan, F., 2013). Their methodology has three goals: minimise total monetary cost, maximise total quality, and maximise service level. The provided interactivity allows the decision maker to incorporate his preferences during the optimization process's iterations.

III. RESEARCH METHODOLOGY

Analytical Hierarchy Process (AHP) was used to analyse the data. AHP is a mathematical tool for making multi-criteria decisions (Saaty, 2008). It performs pair-wise comparisons to determine the relative importance of the criteria at each level and/or computes the alternatives in order to make the best decision at the bottom of the hierarchy (Sharma, & Thangaiah, 2013). AHP is superior to other multi-criteria techniques because it is designed to work with both tangible and intangible criteria, especially when subjective judgments of different experts play an important role in decision making (Saaty, 2008; Dalalah, Hayajneh, & Batieha, 2011). Following the development of the model, we divide our goal in the hierarchy decision-making process (Viswanathan, 2005). A pairwise comparison questionnaire was created to collect the data. Experts from industry and academia were chosen based on their experience and research work, and data was gathered through personal interviews. The data was collected, compiled, and analysed in Microsoft Excel $C = C_j : j = 1, 2, 3, 4, \dots, n$ denotes the set of decision

criteria. The data from the pairwise comparison of n sub-criteria can be summarised in matrix $A = [a_{ij}]_{n \times n}$, with each element $a_{ij} : i, j = 1, 2, 3, 4, \dots, n$ representing the quotient of the criteria weights. A square and reciprocal matrix can be used

to illustrate this pairwise comparison. For all experts, we would have $(n \times n)$ matrices in this matrix $a_{ij} = 1/a_{ji}$ the geometric mean of all matrices was then calculated to create a Geometric mean matrix (Dalalah, 2011). We can calculate arithmetic mean, but since we have ratio properties, we will use geometric mean (Aragon, Dalnoki-Veress, & Shiu, 2012).

3.1 Objective of the Study

To incorporate the decision making capabilities of fuzzy logic to conventional AHP and derive AHP Model on the assessment of technological innovation

3.2 Model Analysis

The factor analysis was conducted on 200 Managers (34 from each Bank) of Both Public (SBI and PNB), Private Banks (33 from each bank HDFC and ICICI) and Foreign Banks (33 from each Bank Standard Chartered Bank and Citibank) in Indore Division.

3.2.1: Fuzzy AHP Model on Multi Decision Criterion on technological Innovation Assessment

Table 1: Decision makers compares the criteria or alternatives based on the Matrices

Saaty Scale	Definition	Fuzzy Triangular Scale
1	Equally Important (Eq. Imp)	(1,1,1)
3	Weakly Important (W. Imp)	(2,3,4)
5	Fairly Important (F. Imp)	(4,5,6)
7	Strongly Important (S. Imp)	(6,7,8)
9	Absolute Important (A. Imp)	(9,9,9)
2	The intermittent values between two adjacent scales	(1,2,3)
4		(3,4,5)
6		(5,6,7)
8		(7,8,9)

3.2.2:

Table 2: Pair Wise Comparisons of Criteria

Q	A.I mp (9,9 ,9)	S.I mp (6,7 ,8)	F.I mp (4,5 ,6)	W.I mp (2,3 ,4)	Criter ion	Eq.I mp (1,1 ,1)	Crit erio n	W . I mp (2 ,3 ,4)	F . I mp (4 ,5 ,6)	S . I mp (6 ,7 ,8)	A.I mp (9, 9,9)
1					Custo mized Servi ces	√	Co mp.				
2	√				Custo mized Servi ces		Cos t				
3		√			Custo mized Servi ces		Effi cien cy				
4			√		Custo mized Servi ces		Red ucti on				
5		√			Comp .		Cos t				
6		√			Comp .		Effi cien cy				
7			√		Comp .		Red ucti on				
8					Cost		Effi cien cy			√	
9		√			Cost		Red ucti on				
10					Effici ency		Red ucti on		√		

3.2.3:

Table 3: Comparison matrices for criteria

CRITERIA	Customized Services	Competitiveness	Cost	Efficiency	Reduction in Client Influx
Customized Services	(1,1,1)	(1,1,1)	(9,9,9)	(6,7,8)	(4,5,6)
Competitiveness	(1,1,1)	(1,1,1)	(6,7,8)	(6,7,8)	(4,5,6)
Cost	(9,9,9)	(1/8, 1/7, 1/6)	(1,1,1)	(6,7,8)	(1/8, 1/7, 1/6)
Efficiency	(1/8, 1/7, 1/6)	(1/8, 1/7, 1/6)	(6,7,8)	(1,1,1)	(4,5,6)
Reduction in Client Influx	(1/6, 1/5, 1/4)	(1/6, 1/5, 1/4)	(1/8, 1/7, 1/6)	(4,5,6)	(1,1,1)

Customized Services $(1*1*9*6*4)^{1/5} (1*1*9*7*5)^{1/5}; (1*1*9*8*6)^{1/5} = 2.93; 3.16; 3.36$

Competitiveness $(1*1*6*6*4)^{1/5}; (1*1*7*7*5)^{1/5}; (1*1*8*8*6)^{1/5} = 2.70; 3.00; 3.28$

Cost Effectiveness $(9*1/8*1*6*1/8)^{1/5}; (9*1/7*1*7*1/7)^{1/5}; (9*1/6*1*8*1/6)^{1/5} = 0.966; 1.05; 1.15$

Efficiency $(1/8*1/8*6*1*4)^{1/5}$; $(1/7*1/7*7*1*5)^{1/5}$; $(1/6*1/6*8*1*6)^{1/5}$ = **0.82; 0.93; 1.06**

Reduction in Client Influx $(1/6*1/6*1/8*4*1)^{1/5}$; $(1/5*1/5*1/7*5*1)^{1/5}$; $(1/4*1/4*1/6*6*1)^{1/5}$ = **0.42; 0.49; 0.57**

3.2.4:

Table 4: Geometric means of fuzzy comparison values

CRITERIA	Geometric Means		
Customized Services	2.93	3.16	3.36
Competitiveness	2.70	3.00	3.28
Cost Effectiveness	0.97	1.05	1.15
Efficiency	0.82	0.93	1.06
Reduction in Client Influx	0.42	0.49	0.57
Total	7.84	8.63	9.42
Reverse (power of -1)	0.127	0.115	0.106
Increasing Order	0.106	0.115	0.127

The fuzzy weight of criterion is found with the help of Geometric mean

$$\begin{aligned} \tilde{w}_1 : & \{2.93*0.106; 3.16*0.115; 3.36*0.127\} = (0.310; 0.363; 0.426) \\ & \{2.70*0.106; 3.00*0.115; 3.28*0.127\} = (0.286; 0.345; 0.416) \\ & \{0.97*0.106; 1.05*0.115; 1.15*0.127\} = (0.103; 0.120; 0.146) \\ & \{0.82*0.106; 0.93*0.115; 1.06*0.127\} = (0.086; 0.106; 0.134) \\ & \{0.42*0.106; 0.49*0.115; 0.57*0.127\} = (0.044; 0.056; 0.072) \end{aligned}$$

3.2.5:

Table 5: Relative Fuzzy weight each of criterion

CRITERIA	\tilde{w}_i		
Customized Services	0.310	0.363	0.426
Competitiveness	0.286	0.345	0.416
Cost Effectiveness	0.103	0.120	0.146
Efficiency	0.086	0.106	0.134
Reduction in Client Influx	0.044	0.056	0.072

IV. RESULTS AND DISCUSSION

Relative non-fuzzy weight of each criterion $M_i = \frac{(w_1 + w_2 + w_3)}{3}$ is calculated by taking the average of all the fuzzy

numbers of each criterion. By using non fuzzy $N_i = \frac{M_i}{\sum M_i}$ the normalized weights of each criterion are calculated and presented in table:

Table 6: Averaged & Normalized weights of Criterion

CRITERIA	M_i	N_i
Customized Services	0.366	0.365
Competitiveness	0.349	0.348
Cost Effectiveness	0.123	0.123
Efficiency	0.108	0.107
Reduction in Client Influx	0.057	0.057

With the help of the Analytical Hierarchy Process, this study investigated the various criteria for understanding bank performance for the assessment of technological advancement (AHP). The five identified criteria are analysed based on expert judgement and experience, and the priority of criteria is determined. A hierarchy of multi decision model HSM is built based on priority. Based on technological innovation in Foreign Banks, Private and Public Banks, the study established five parameters (customised services, competitiveness, cost effectiveness, efficiency, and client flux reduction). Foreign Banks have performed best in terms of customised services, as these banks have Personalized Internet banking services are provided by simply allowing individual customers to customise the layout of the webpage, allowing each customer to have his or her own unique Internet banking webpage after logging onto the Internet banking server. Service personalization entails developing a new service to meet a specific need of a single customer. Individual customers receive online personalised financial advice from banks based on their transaction history and personal preferences. Foreign bank officials are constantly in contact with their customers in order to obtain feedback on their services in order to improve them.

The hierarchy structure model only explains the priority of criteria/sub-criteria but not their interrelationship. Future research can be conducted to determine the interrelationship, i.e. the cause and effect relationship between criteria and sub-criteria.

REFERENCES

1. Aragon, T. J., Dalnoki-Veress, F., & Shiu, K. (2012). *Deriving criteria weights for health decision making: A brief tutorial*. Berkeley, CA: Center for Infectious Diseases & Emergency Readiness. Retrieved from <http://escholarship.org/uc/item/4366g5pv>
2. Arikan, F., (2013) "An interactive solution approach for multiple objective supplier selection problem with fuzzy parameters", *Journal of Intelligent Manufacturing*, DOI: 10.1007/s10845-013-0782-6.
3. Baležentis, A., Baležentis, T., & Misiunas, A. (2012). An integrated assessment of Lithuanian economic sectors based on financial ratios and fuzzy MCDM methods. *Technological and Economic Development of Economy*, 18(1), 34-53
4. Chakravarti, N. (2013). *Internet users in India crosses 200 million mark* [online]. Retrieved 13 January 2014 from
5. Chen, C. F. (2006). Applying the analytical hierarchy process (AHP) approach to convention site selection. *Journal of Travel Research*, 45(2), 167–174.
6. Cheng, Y. H. (2011). Evaluating web site service quality in public transport: Evidence from Taiwan High Speed Rail. *Transportation Research Part C: Emerging Technologies*, 19(6), 957–974.
7. Dalalah, D., Hayajneh, M., & Batieha, F. (2011). A fuzzy multi-criteria decision making model for supplier selection. *Expert Systems with Applications*, 38(7), 8384–8391
8. Dash, M. K., & Kumar, A. (2014). Electronic consumer style inventory: Factor exploration and multi-comparison analysis. *Asian Academy of Management Journal*, 19(2), 43–65.
9. Doumpos, M., & Zopounidis, C. (2015). A multicriteria approach to bank rating. In Bisdorf, R., Dias (eds), *Evaluation and Decision Models with Multiple Criteria* (pp. 563-587). Springer, Berlin, Heidelberg.
10. Doumpos, M., & Zopounidis, C. (2013). Efficiency and performance evaluation of European cooperative banks in Efficiency and Productivity Growth: Modelling in the Financial Services Industry, ed. Pasiouras, F., John Wiley & Sons, Ltd, Chichester, UK.
11. Hwang, C.L., and Yoon, K., (1981) *Multiple Attribute Decision Making Methods and Applications: A State of the Art Survey*, Springer-Verlag, USA
12. Keisidou, E., Sarigiannidis, L., & Maditinos, D. (2011). Consumer characteristics and their effect on accepting online shopping, in the context of different product types. *International Journal of Business Science & Applied Management*, 6(2), 31–51.
13. Kilic, H.S., (2013) "An integrated approach for supplier selection in multi item/multi supplier environment", *Applied Mathematical Modelling*, Vol. 37 (14-15), 7752-7763.
14. Kilincci, O., & Onal, S. A., (2011) "Fuzzy AHP approach for supplier selection in a washing machine company", *Expert Systems with Applications*, Vol. 38(8), 9656-9664.
15. Lu, J., Yao, J. E., & Yu, C. S. (2005). Personal innovativeness, social influences and adoption of wireless internet services via mobile technology. *The Journal of Strategic Information Systems*, 14(3), 245–268
16. Önüt, S., Kara, S.S., and Işık, E., (2009) "Long Term Supplier Selection Using a Combined Fuzzy MCDM Approach: A Case Study for a Telecommunication Company", *Expert Systems with Applications* Vol. 36(2), 3887-3895.
17. Petkovic, J., Sevarac, Z., Jaksic, M.L., Marinkovic, S., (2012) "Application of fuzzy AHP method for choosing a technology within service company", *Technics Technologies Education Management*, Vol.7(1), 332-341
18. Rogers, E. M. (2010). *Diffusion of innovations* (4th ed.). New York: Simon and Schuster.
19. Saaty, T.L., (1980) *The Analytic Hierarchy Process*, McGraw-Hill, New York, USA.
20. Shaw, K., Shankar, R., Yadav, S.S., and Thakur, L.S., (2012) "Supplier Selection Using Fuzzy AHP and Fuzzy Multi Objective Linear programming for developing low carbon supply chain", *Expert Systems with Applications*, Vol. 39(9), 8182-8192.
21. Sheth, M. (2013). *Re-birth of e-commerce in India* [online]. Retrieved 12 January 2014 from <http://www.ey.com/IN/en/Industries/Technology/Re-birth-of-e-Commerce-in-India>.
22. Sundharam, V. N., Sharma, V., & Thangaiah, I. S. (2013). An integration of BSC and AHP for sustainable growth of manufacturing industries. *International Journal of Business Excellence*, 6(1), 77–92
23. Viswanadhan, K. G. (2005). How to get responses for multi-criteria decisions in engineering education—an AHP based approach for selection of measuring instrument. *Financial Support*, 20–28.
24. Yahya, S. and Kingsman, B., (1999) "Vendor Rating for an Entrepreneur Development Programme: A Case Study Using the Analytic Hierarchy Process Method", *Journal of the Operational Research Society* Vol.50: 916-930.
26. Zadeh, L.A., (1965) "Fuzzy Sets", *Information and Control* Vol.8 (3), 199-249.