Digital Banking Chatbots related MCDM Problem by TODIM Strategy in Pentagonal Neutrosophic Arena

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Abstract
Chatbots is an amalgamation of two words, Chats and bots. The meaning of Chat is to talk and bots are robots. Thus specifically Chat bots are talkative robots. The machine which is planned and controlled by a computer is called Robot. The banking business has become 24/7, and hence there arises the requirement to provide 24/7, 365 days a year services to customers. By any means, this is impossible for any human being, and for this reason, the machine was required to be invented. Even the multifaceted problems can be solved by robots with the help of external human force or with entrenched system rule. Humans are replaced by robots in doing tough, dangerous, and recurring activities that could not be performed by the former because of their restrictions. In banks, Robots Process Automation can reduce operational errors, reduce the cost of human capital, and has the potential to do multitask 24/7 without fatigue and 100% success rate. The fundamental of this paper is to appreciate the necessity of robotics process automation in the West Bengal banking industry. A pentagonal neutrosophic number (PNN) based Tomada de decisao interativa e multicritévio (TODIM) method multi-criteria decision making (MCDM) problem is included here to uncover the most vital chatbots factors these days. This study would assist in gaining insights on the consequence of the beginning of RPA in the Banking sector and its overall impact on Customer Relationship Management.

Keywords: Chatbots; Pentagonal neutrosophic number; TODIM; Multi-criteria decision making (MCDM)

Introduction:

Banks have started using chatbots for providing customer support as they offer a big number of multifaceted products and services. Chatbots commences programmed system for communication with customers 24/7/365 days. (Takuma Okuda, 2018) [1]. Chatbots is a computer programming software that customers can talk to through chat windows or messaging apps (Meghna Singh, 2018) [2]. Banks are using comparative advantage by improving decision-making abilities with the help of AI. (Agarwal, 2019) [3]. These bots assist in bringing customer satisfaction by improving their services. Banks offer different products and services with their help. We know that feedback from the customer is very significant in the banking process. Chatbots help banks to collect more specific feedback from customers that help them to evaluate their services and to improve them. Chatbots can also be used in different social media apps like WhatsApp, Messenger, etc. to answer queries from customers. The chatbots can be used by banks where human involvement is required as robots may give more Banks can use chatbots in areas where human intervention is required because it can give more accurate and timely outcomes with minimum cost. AI is used by bank to accomplish its purpose of offering extremely tailored services which will convince customers, enhance interaction with them and improve commitment and customer retention by augmenting customer lifetime worth, to draw more revenue (Oladapo Oyebode, 2018) [4]. Customers' can trace valuable information through chatbots. Banks are using chatbots for customized customers' services and these improved services will help to achieve improved customer satisfaction.

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1.1. Chat-bots:

Chatbots are invented due to the requirement of initiation of interaction between Human and Computer. It uses ordinary language. The excessive use of PCs has begun the craving to converse with computers in the same way as a human, by using natural language (Bayan Abu Shawar, 2007) [5]. Chatbots; exploit natural language technologies to engage users in text-based and task-oriented communication (Hermès Meerschman, 2019) [6], (Christiane Volkle, 2019) [7]. He defines chatbots as an interactive tool for messaging as developed by Artificial Intelligence (AI) (Schlicht, 2016) [8]. He describes chatbots as a developed service that we use to network with through a chat interface. (Eeuwen, 2017) [9]. It was briefed as a bright software program which is used to communicate with its users using ordinary language through chat used for business reasons.

1.2. History of Chat-bots:

ELIZA is the world's oldest and best-known Chat-bot. It was used to perform the function of a psychiatric therapist in clinical healing, Joseph Weizenbaum, an MIT scientist created it in the '60s (Weizenbaum, 1966) [10]. These days, Eliza may look incomplete but her fundamental technological method is still at the basis of the most modern chatterbots. Since ELIZA, the journey of chatbots equipped with AI and machine learning has come an extensive way. This is generally considered as one of the first chatbots which were able to dupe its consumers. It could flag vital keywords by inspecting the key in the message. Today, chatbots have become a vital part of the banking industry, helping banks build up their services (Entesam H Almansor, 2019) [11].

Journey of Chatbots: Due to the strengthening of technology chatbots have created a larger impact for stakeholders over the last decade.

2010: A SIMPLE DIGITAL TOOL:

- It answered customer queries through FAQs and at a much reduced time,
- It was having a structured database and recognizing definite keywords in queries,
- It forwarded all inquiries beyond the database to employees for decision.

2014- CONVERSATIONAL ANALYTICS PLATFORM

- It can consider planned and unplanned data stored in large quantities & at high speed through conversational analytics and natural language processing capabilities and provide real-time decision making

2017- A DIGITAL ASSISTANT

- It begins action on its own.
- It can perform multiple tasks on its own.

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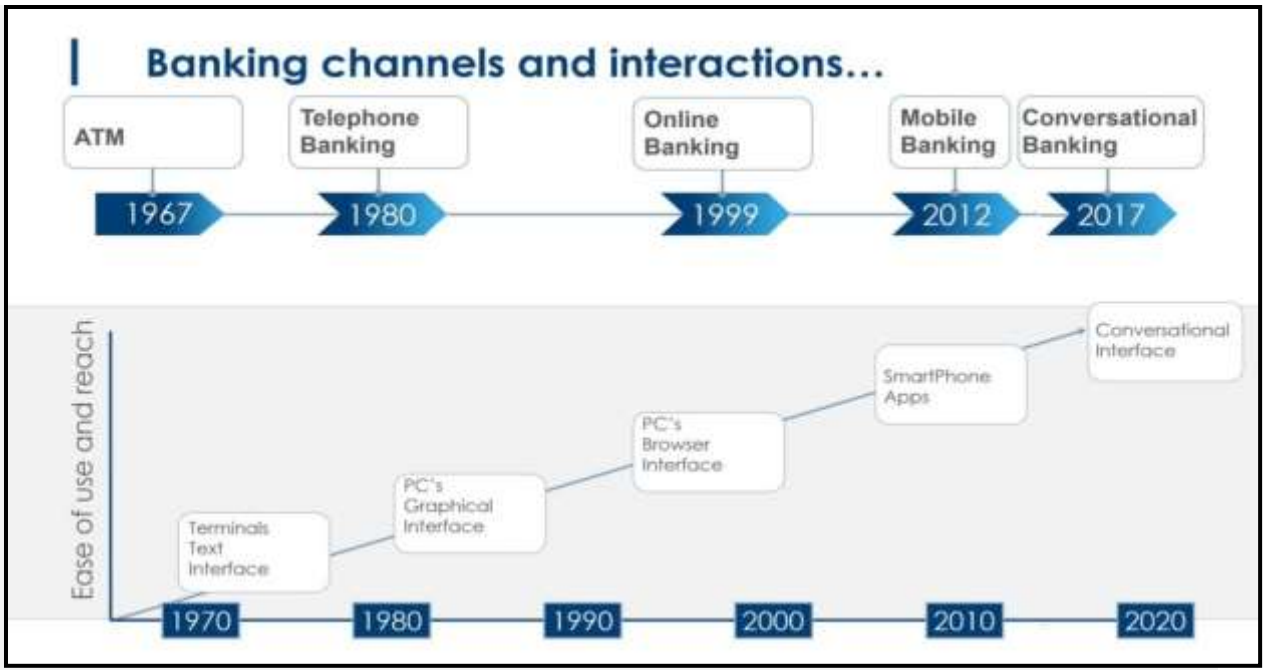

Figure 2: Banking channels and iteractions

1.1. Chatbots in Banking Industry:

One of the early adopters of chatbots in the banking industry. As predicted by Juniper Research the success rate of bot interactions in the banking sector is going to reach 90% by 2022. Chatbots are refined computer software programs designed to interact with customers similarly to humans. It helps in increasing customer satisfaction by replying to all their queries within seconds in comparison to IVR which delays in responding to customers by often putting their calls in queue. Customers find it desirable to use chatbots that reply to their queries in real-time (Jewandah, 2018) [12]. The customer asks ordinary questions like account balance query, utility payments, balance transfer, ATM locator, etc., and the same was answered by bots in a flawless and time-bound manner. The bot understands the customers' perception with predictive analytics and answers accordingly. Some banks have developed bots that block the customers' cards in case of theft. With uninterrupted support, 24 x 7, chatbots are creating meaningful customer relationships. With the increasing complexities, chatbots have turned out to be more action-oriented. Now they have gone beyond simply answering queries and are making customized products based on human perception and need. When bots are handling customer queries, employees can concentrate on the area where human intervention is a must.

It can handle multiple queries at the same time. Bots help Banks by handling millions of inquiries in a month at a much cheaper cost in comparison if the same is done by employees. Hence, bots are helping banks to save up-front costs and the Juniper Research study suggests that banks could save over USD 8 billion by 2022 with the help of bots (Vijai, 2019) [13].

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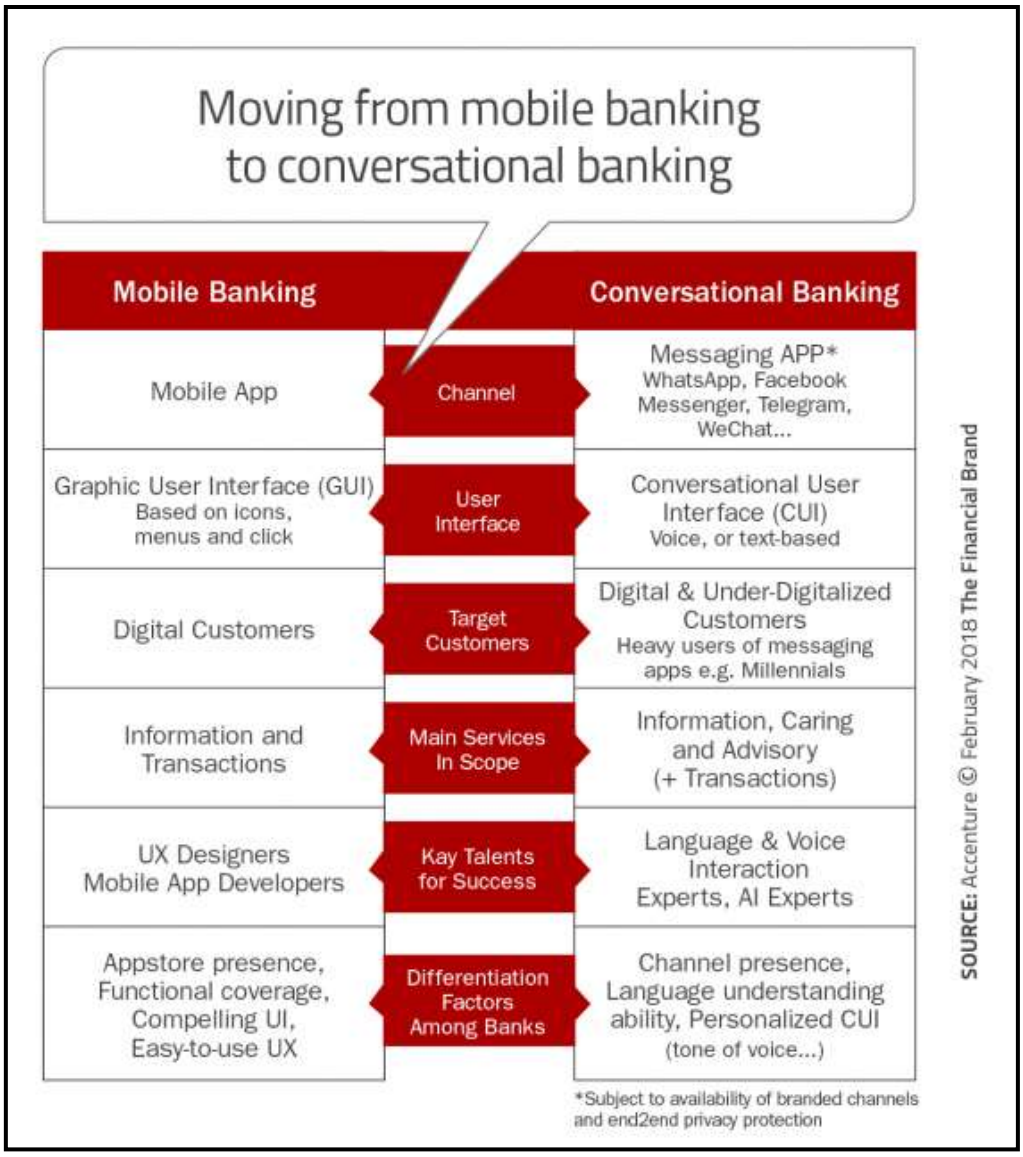

Figure 2: Moving from mobile banking to conversational banking

1.4 Theory of Vagueness

Due to the thriving advance of uncertainty and hesitation in human thoughts, L.A.Zadeh in 1965, [14] patronized an extraordinary observation of fuzzy set theory, which has been extensively functional on distinctive disciplines of science and engineering. In recent times, researchers put forth the perceptions of pentagonal [15], Hexagonal [16], Heptagonal [17] fuzzy numbers in the research sphere. Successively Atanassov [18] in 1986 conceptualized the consideration of intuitionistic fuzzy set (IFS) which is an agreeable combination of membership and non-membership function. Later, in 1998, F. Smarandache [19] projected the formation of the neutrosophic set (NS) and extended the idea of NS which can grasp any kind of practical problem reasonably more efficiently as it depicts the three membership functions namely truthiness, falseness, hesitant. In continuation with that, in 2019, Chakraborty et al. [20,21] promoted the impression of pentagonal neutrosophic number (PNN) and additionally, established the understanding of classification [22] of PNN in the research area.

2. Literature Review:

Chatbot conversational agents are software programmes that converse with users in ordinary language. (Eeuwen M. v.) [9]. AI chatbots can be used to automate the Banking Industry by communication between customers and banks (Griol, Shawar, & Kerly, 2017) [23]. Communication is done by creating output as a natural language (McTear, Callejas, & Griol, 2016) [24]. For quite some time, chatbots have been employed in online banking transactions, now it is shifting to mobile messenger interfaces. Conversational commerce is now coming into the pictures with mobile messenger chatbots being used for commercial purposes. Customers can do online

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shopping, and chatbots can react via communication, advice, keep informed and call to action buttons (Kumar, 2016) [25]. With the advancement in AI, chatbots can recognize customers' moods and intent and accordingly suggest offerings and plans based on customers' preferences. It can then boost sales and customers satisfaction in the long run as it helps in providing customized services (Latimore, 2018) [26].

2.1 Indian banking chatbots/virtual assistants: a brief explanation (Kochar, Purohit, & Chutani, 2019) [27].

2.1.1 State bank of India: SBI's artificial intelligence-powered software chatbot is called SIA. It can process 10,000 requests per second and 864 million questions per day, accounting for almost 25% of all searches handled. This is, without a doubt, India's and the world's largest operation. Initially, it responded to common questions about its goods and services, ATMs, and IFSC codes, among other things. (Baruah, 2019) [28].

2.1.2 HDFC Bank: Electronic Virtual Assistant or EVA was 1st Artificial Intelligence-powered banking chatbot of HDFC Bank. It employed artificial intelligence (AI) and natural language processing to respond to client enquiries in milliseconds. It has already answered over 5 million enquiries from over a million clients with an accuracy rate of over 85%. (Suprita Das, 2018)[29], (Maru, 2018) [30]. It makes 20,000 chats daily with customers from all over the world. (Source: HDFC Bank Website). It has handled more than 7500 FAQs and more than 16 million conversations on Banks's products and services with an accurateness of over 90%.

2.1.3 ICICI Bank: The Artificial Intelligence (Al)-powered chatbot, iPal of ICICI Bank has finished 6 million responses to date. It has handled nearly one million monthly enquiries on both the website and mobile apps, giving clients with resolutions around the clock. (Maru P., 2017) [30] The chatbot has answered questions with a 90% accuracy rate. With platforms like Google Assistant, Siri, and Facebook Messenger, this chatbot offered vernacular languages and speech capability. (Mukherjee, 2017) [31].

2.1.4 Yes Bank: The natural language processing and AI-powered chatbot of Yes bank are YES ROBOT. It has already communicated with 9.8 million clients with 90% accuracy since its introduction. (ETCIO, 2019) [31], (James, 2019) [32]. To enhance the user experience for getting 360-degree customer information the Bank is planning to add more features of voice-based commands.

2.1.5 IndusInd Bank: Indusassist is the IndusInd bank's artificial intelligence-powered chatbot. It has been linked to Amazon's Alexa in order to allow customers to obtain financial services just by speaking with Alexa. The bank is attempting to carry banking ahead of the banking channels to the Internet of Things by combining their chatbot "Indusassist" with Alexa. (Bureau, 2018) [35].

2.1.6 Kotak Bank: Keya, Kotak Bank's chatbot, has answered 3.5 million enquiries from over 1 million exclusive clients with a 93 percent accuracy rate since its launch. To assist its consumers, it employed natural language and automated speech recognition. (Bhakta, 2018) [36].

2.1.7 Axis Bank: Axis Bank's chatbot, Aha, is likewise an AI-based chatbot that was developed in collaboration with Active AI, a Singapore-based tech business.(Asiaone, 2019) [37]. This is the most powerful version since it can respond to financial transactions via speech and text. (PersonalFn, 2018) [38].

2.1.8 Andhra Bank: Andhra Bank's chatbot, ABHI, uses artificial intelligence and natural language processing to serve its 5 million clients. (Service, 2019) [39]. Users will be able to connect with the chatbot via WhatsApp. (UNI, 2019) [40].

2.1.9 Bank of Baroda: IBM Watson's API powers Bank of Baroda's Assisted Digital Interaction (ADI). (Infotechlead, 2018) [41]. The chatbot, according to the bank, also addressed product-related questions. (S, 2018) [42].

2.1.10 Union Bank of India: The Union Bank of India (UBI) debuted the UVA chatbot on its 99th anniversary. (Release, 2017) [43]. Apart from that, the bank hasn't divulged much information to the public. Data about technology partners and the amount of inquiries handled/responded to by the chatbot is not yet publicly accessible.

2.1.11 Canara Bank: To respond to consumer inquiries To address consumer queries, Canara Bank introduced two robots, Mitra and CANDI. In addition to question processing, the bot may also act as a security guard. With an HD camera, the bot acts as a security guard and remains vigilant throughout the night. (Thomas, 2017) [44].

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CANDI operates in two modes: regular mode, which answers numerous questions, and banking mode, which answers 215 questions. (Patranobis & Gopal, 2017) [45].

2.2 Literature Survey on Multi-Criteria Decision-Making Problem (MCDM): In this current epoch, MCDM is one of the prevailing topics in decision-controlled investigations. In recent times, it is more crucial in such scenarios where a cluster of criteria is incorporated. For such circumstances, multi-criteria group decision-making problems (MCGDM) encompassed a large scale of applications. Taking into consideration the MADM or MCDM problem using the attribute value of SVNN, the ELECTRE technique was applied to resolve the proposal by Peng et al. [46]. On the ground of the ELECTRE process, Zhang et al. [47] projected a MADM difficulty with INS. Karasan and Kahraman [48] planned an excellent technique on the interval-valued neutrosophic EDAS process for MCDM setback. Xu et al. [49] explained whether the decision in order is agreed by SVNSs or INSs and obtained the analogous solutions of MADM problems. An innovative aggregation operator of SVN soft numbers was utilized by Chiranjibe and Madhumangal [50] for standing the alternatives in MADM problems. TODIM (a contraction in Portuguese for multi-criteria decision-making approach named Tomada de decisao interativa e multicritévio) is an imperative MADM tactic since it is reliable in the decision makers' enclosed prudence. Initially, Gomes and Lima [50] utilized the TODIM plan based on prospect theory. Krohling and Souza [51] discussed the fuzzy TODIM policy to work out MCDM problems. In 2017, Xu et al. [52] built up the TODIM tactic in single-valued neutrosophic surroundings and comprehended it into an interval neutrosophic background. In this observable fact, Vikor [53], TOPSIS [54], MOORA [55], GRA [56] strategies are erected to crack decision-making problems through some apposite and reasonable operators in neutrosophic theory. Thus, in the case of social science-associated doubtful facts, the decision-making crisis becomes one of the well-discussed topics in the neutrosophic realm.

In this research article, we consider a PNN based MCDM technique to select the most important Chabot factor in the digital banking sector. Here, we collect all the information's from the distinct online digital bank based on their online marketing report. But, we observed that these data are fluctuating and filled with lots of hesitations. Now, due to the presence of impreciseness, we need to improve our general established method. Thus, we have introduced PNN to tackle this system for better results. Additionally, we also incorporate different weights in distinct attribute functions as well as the decision maker's choice. Finally, we solved a digital marketing Chabot-related TODIM based MCDM problem in the PNN environment. This noble thought will help researchers to tackle MCDM problems in future work.

3. Mathematical Preliminaries:

Definition 3.1: Neutrosophic Set: A set $\tilde{S}_N$ is the universe of discourse of R most frequently defined as σ is recognized as a neutrosophic set if $\tilde{S}_N = \{\langle \sigma; [\varphi_{\widetilde{R_N}}(\sigma), \delta_{\widetilde{R_N}}(\sigma), \emptyset_{\widetilde{R_N}}(\sigma)]\rangle : \sigma \epsilon R\}$, where $\varphi_{\widetilde{S_N}}(\sigma): R \to]-0,1+$ [stands for the index of accuracy, $\delta_{\widetilde{S_N}}(\sigma): R \to]-0,1+$ [stands for the index of confusion and $\emptyset_{\widetilde{S_N}}(\sigma): R \to]-0,1+$ [represents the index of inaccuracy in the decision making process. Where, $[\varphi_{\widetilde{R_N}}(\sigma), \delta_{\widetilde{R_N}}(\sigma), \emptyset_{\widetilde{R_N}}(\sigma)]$ satisfies the inequality

$$-0 \leq Sup\ \varphi_{\widetilde{S_N}}(\sigma) + Sup\ \delta_{\widetilde{S_N}}(\sigma) + Sup\ \emptyset_{\widetilde{S_N}}(\sigma) \leq 3+.$$

Definition 3.2: Single-Valued Neutrosophic Set: A Neutrosophic set defined in the definition 3.2 is $\tilde{S}_N$ is supposed to be a Single-Valued Neutrosophic Set $(\widetilde{SV}_N)$ if ϵ is a single-valued self decisive variable. $\widetilde{SV}_N = \{\langle \epsilon; [\partial_{\tilde{S}_N}(\epsilon), \pi_{\tilde{S}_N}(\epsilon), \theta_{\tilde{S}_N}(\epsilon)]\rangle : \epsilon \in R\}$, where $\partial_{\tilde{S}_N}(\epsilon), \pi_{\tilde{S}_N}(\epsilon)$ & $\theta_{\tilde{S}_N}(\epsilon)$ signify the view of accuracy, confusion and fallacy membership functions respectively. $\widetilde{S_{NC}}$ is named neut-convex, which implies that $\widetilde{S_{NC}}$ is a subset of R by fulfilling the following principles:

i. $\partial_{\tilde{S}_N}\langle \omega k_1 + (1-\omega)k_2\rangle \geq min\langle \partial_{\tilde{S}_N}(k_1), \partial_{\tilde{S}_N}(k_2)\rangle$
ii. $\pi_{\tilde{S}_N}\langle \omega k_1 + (1-\omega)k_2\rangle \leq max\langle \pi_{\tilde{S}_N}(k_1), \pi_{\tilde{S}_N}(k_2)\rangle$
iii. $\theta_{S_N}\langle \omega k_1 + (1-\omega)k_2\rangle \leq max\langle \theta_{\tilde{S}_N}(k_1), \theta_{\tilde{S}_N}(k_2)\rangle$

$$where\ k_1 \& k_2 \in \mathbb{R}\ and\ \omega \in [0,1]$$

Definition 3.3: Single-Valued Pentagonal Neutrosophic Number: A Single-Valued Pentagonal Neutrosophic Number $(\widetilde{P_N})$ is designated as $(\widetilde{P_N}) = \langle [(v_1, v_2, v_3, v_4, v_5); \alpha], [(v_1, v_2, v_3, v_4, v_5); \beta], [(v_1, v_2, v_3, v_4, v_5); \gamma]\rangle$, where $\alpha, \beta, \gamma \in [0,1]$.The exactness memberships function $(\varphi_{\tilde{R}}): \mathbb{R} \to [0, \alpha]$, the uncertain membership function $(\emptyset_{\tilde{R}}): \mathbb{R} \to [\beta, 1]$ and the falseness membership function $(\mu_{\tilde{R}}): \mathbb{R} \to [\gamma, 1]$ are defined by:

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$$\varphi_{\tilde{R}}(x)=\begin{cases}\dfrac{\alpha(x-v_1)}{(v_2-v_1)} & v_1\le x\le v_2\\ \dfrac{\alpha(x-v_2)}{(v_3-v_2)} & v_2\le x<v_3\\ \alpha & x=v_3\\ \dfrac{\alpha(v_4-x)}{(v_4-v_3)} & v_3<x\le v_4\\ \dfrac{\alpha(v_4-x)}{(v_5-v_4)} & v_4\le x\le v_5\\ 0 & otherwise\end{cases},\emptyset_{\tilde{R}}(x)=\begin{cases}\dfrac{v_2-x+\beta(x-v_1)}{(v_2-v_1)} & v_1\le x\le v_2\\ \dfrac{v_3-x+\beta(x-v_2)}{(v_3-v_2)} & v_2\le x<v_3\\ \beta & x=v_3\\ \dfrac{x-v_3+\beta(v_4-x)}{(v_4-v_3)} & v_3<x\le v_4\\ \dfrac{x-v_4+\beta(v_5-x)}{(v_5-v_4)} & v_4\le x\le v_5\\ 1 & otherwise\end{cases}$$

$$\mu_{\tilde{R}}(x)=\begin{cases}\frac{v_2-x+\gamma(x-v_1)}{(v_2-v_1)} & v_1\le x\le v_2\\ \frac{v_3-x+\gamma(x-v_2)}{(v_3-v_2)} & v_2\le x<v_3\\ \gamma & x=v_3\\ \frac{x-v_3+\gamma(v_4-x)}{(v_4-v_3)} & v_3<x\le v_4\\ \frac{x-v_4+\gamma(v_5-x)}{(v_5-v_4)} & v_4\le x\le v_5\\ 1 & otherwise\end{cases} \quad \text{..... (1)}$$

Definition 3.4: Proposed Score Function: The necessity of score function in the pentagonal neutrosophic field is to revolve a neutrosophic fuzzy number into a crisp one. The score function completely depends on the measure of truthiness, uncertainty, and falseness. Here we characterize a new score function in a pentagonal neutrosophic situation. Therefore for any single typed pentagonal neutrosophic number

$$\tilde{n}_{Neu}=(a_1,a_2,a_3,a_4,a_5;T_{Pt},I_{Pt},F_{Pt})$$

We describe the score function as:

$$N_{Sc}=\frac{1}{15}(a_1+a_2+a_3+a_4+a_5)\times(2+T_{Pt}-I_{Pt}-f_{Pt})\text{...(2)}$$

4. Research Methodology:

The information was gathered from a variety of sources, including students and employees of various organizations in West Bengal, mostly in the education and service sectors, as well as corporate, government, and public sector corporations and businesses. A total of 325 people took part in the survey. We utilized a five-point Likert scale, with 1 indicating strong agreement and 5 indicating extreme disagreement. Males account for 58.15 percent of responders, while females account for 41.85 percent.

Research Instrument: In this study, the independent variable is Demographic Profile. The questionnaire is mainly focused on: awareness of chatbots in the Banking Industry and the comparison of chatbots with mobile apps.

Table 1: Respondents' Demographic Details

DISTINCTIVENESS	CATEGORY	OCCURRENCE	%
GENDER	M	189	58.15384615
	F	136	41.84615385
AGE	<25	154	47.38461538
	25-40	126	38.76923077
	>40	45	13.84615385

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OCCUPATION	EMPLOYED	131	40.30769231
	PROFESSIONAL	53	16.30769231
	STUDENT	141	43.38461538

4.1 SOURCE: QUESTIONNAIRE

Table 2: Indicate acceptance of Chatbots

Questions	**Effectiveness**	**Speed**	**Safety**	**Ease of Use**
Strongly Disagree	25	24	16	19
Disagree	74	89	81	73
Neutral	82	83	101	83
Agree	110	102	106	113
Strongly Agree	34	27	21	37

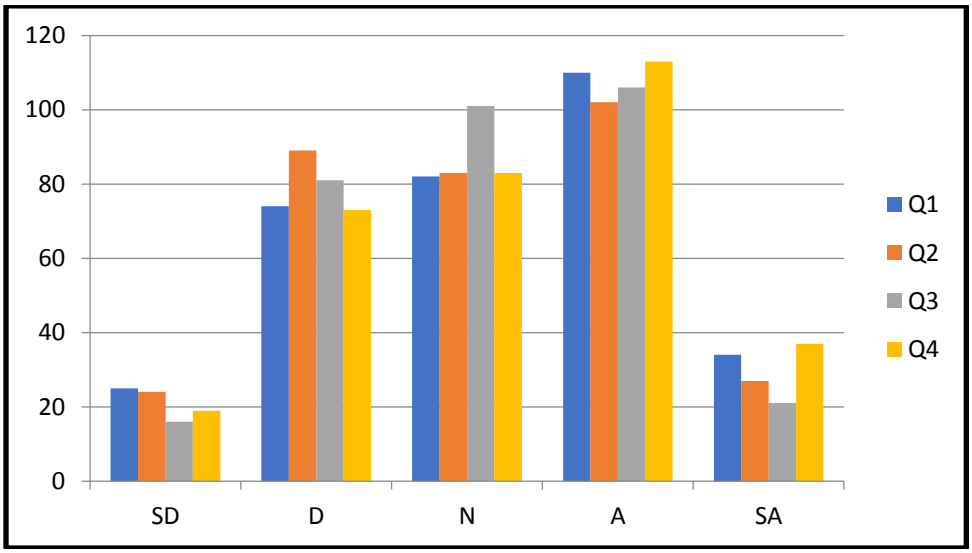

Figure 3: acceptance of Chatbot

5. MCDM Problem in Pentagonal Neutrosophic Environment:

In the modern age of uncertainty and dilemma, MCDM setback is one of the authentic and consistent topics to cope with indistinctness and vagueness. The major function of this approach is to sort out the superlative alternative among the limited individuals based on their finite distinct attribute standards. Thus decision-making approach can be built up vigorously by the guidelines of MCDM which is extraordinarily trustworthy to fabricate decision verdicts and gives enthusiasm in way of proceedings of amenities with circumstances of better choice allocations, sustaining superior communication productivity. The arrangements of the development are rationally tactful in PNN ground with the relevance of recognized mathematical operators, score function, and the well-known algorithm.

5.1 TODIM Strategy for Multi-Criteria Decision Making Problem under Pentagonal Neutrosophic Number Environment

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In this section, we consider Q= $\{Q_1, Q_2, Q_3, \ldots\ldots Q_m\}$ be the set of m alternatives and P=$\{P_1, P_2, P_3, \ldots\ldots P_n\}$ be the set of n criteria. Also the $\gamma = \{\gamma_1, \gamma_2, \gamma_3, \ldots . \gamma_n\}$ be the

correlated weight set criterion where each $\gamma_i \geq 0$ and also satisfies the relation $\sum_{i=1}^{n} \gamma_i = 1$.

Thus we construct a decision matrix D=$(d_{ij})_{mn}$ where each entry defines a pentagonal neutrosophic number and clarifies Q_i over P_j.

The following steps exhibit the completeness of the strategy.

Step-1: Here, we construct the decision matrix under the related finite alternatives and finite set of criteria. The remarkable point is that the entities dij of the matrix are all pentagonal neutrosophic numbers. Thus we develop the matrix which is given as follows:

$$D = \begin{pmatrix} . & P_1 & P_2 & P_3 & . & . & . & P_m \\ Q_1 & d_{11} & d_{12} & d_{13} & . & .. & . & d_{1m} \\ Q_2 & d_{21} & d_{22} & d_{23} & . & . & . & d_{2m} \\ Q_3 & \cdot & \cdot & \cdot & . & \cdot & \cdot & \cdot \\ . & \vdots & . & . & . & \cdot & \cdot & \cdot \\ Q_n & d_{n1} & d_{n2} & d_{n3} & . & . & . & d_{nm} \end{pmatrix} \ldots(3)$$

Step-2: Forming the corresponding weights Δ_j $(j = 1,2,..n)$of the criterion.

Step-3: Compute the relative weight ω_j, j = 1,2, ... n of each criterion by the defined equation $\omega_j = \frac{\Delta_j}{\Delta_{max}}$ …(4) where Δ_{max}= max$\{\Delta_1, \Delta_2, \ldots \Delta_n\}$

Step-4: Compute the score values of each alternative w.r.t the criterion utilizing the equation (2) and formulate the score valued decision matrix $S = (s_{ij})_{mn}$

$$S = \begin{pmatrix} s_{11} & s_{12} & s_{13} & . & .. & . & s_{1m} \\ s_{21} & s_{22} & s_{23} & . & . & . & s_{2m} \\ \cdot & \cdot & \cdot & . & \cdot & \cdot & \cdot \\ \vdots & . & . & . & \cdot & \cdot & \cdot \\ s_{n1} & s_{n2} & s_{n3} & . & . & . & s_{nm} \end{pmatrix} \ldots(5)$$

Step-5: In this step we compute dominance matrix of each alternative relative to the criteria by the following settled down formula.

$$\pi_k(d_i, d_j) = \begin{cases} \sqrt{\frac{\omega_k \, \delta(\tilde{d}_{ik}, \tilde{d}_{jk})}{\sum_{k=1}^{n} \omega_k}}, if \ \tilde{d}_{ik} > \tilde{d}_{jk} \\ 0 \ , if \ \tilde{d}_{ik} = \tilde{d}_{jk} \\ -\frac{1}{\theta}\sqrt{\frac{\sum_{k=1}^{n} \omega_k \, \delta(\tilde{d}_{ik}, \tilde{d}_{jk})}{\omega_k}}, if \ \tilde{d}_{ik} < \tilde{d}_{jk} \end{cases} \ldots(6)$$

Where θ denotes the decay factor and $\theta > 0$.

Step-6: In this step, we calculate aggregated dominance value of each alternative by the below-defined formula.

$$\vartheta(d_i, d_j) = \sum_{k=1}^{n} \pi_k(d_i, d_j) \ldots(7)$$

Step-7: In this step we compute the dominance degree of each alternative Q_i by the below defined formula.

$$\tau_i = \frac{\sum_{j=1}^{n} \vartheta(d_i, d_j) - \min\limits_{1 \leq i \leq m} (\sum_{j=1}^{n} \vartheta(d_i, d_j))}{\max\limits_{1 \leq i \leq m} (\sum_{j=1}^{n} \vartheta(d_i, d_j)) - \min\limits_{1 \leq i \leq m} (\sum_{j=1}^{n} \vartheta(d_i, d_j))} \ldots(8)$$

for $i = 1,2, \ldots m$.

Step-8: In this step, we rank the alternatives Q_i following their dominance degree. The highest degree value is the best alternative.

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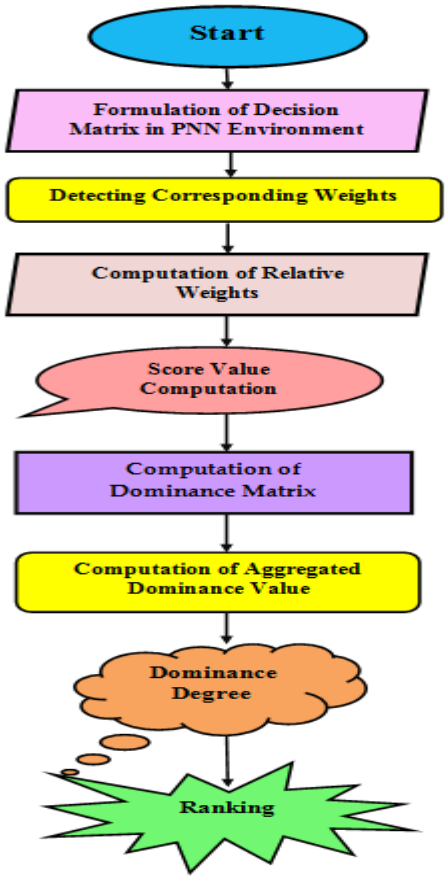
5.1 Flowchart:



Pseudocode of the TODIM method

1. Set Alternatives Q_i, Criterion P_j, Weights Δ_j, Hamming distance δ_{ij};
2. D← PNN expressions (Q_i, P_j) ; /* formation of decision matrix via PNN expressions*/
3. ω_j ← Weights of Criterion (Δ_j); /* Compute the relative weight vector via the weight vector of the criterion using Eq (4) */
4. S← PNN Decision matrix (D); /* expressing score valued matrix using the score function mentioned in Eq(2) */
5. $\pi_{j\leftarrow}$ Distance measure (δ_{ij}, Δ_j); /* computing dominance matrices via distance measure formula and weight vector*/
6. ϑ_{ij} ← Dominance matrix (π_j); /* computing the aggregated dominance value via dominance matrix*/
7. τ_i ←Aggregated dominance value (ϑ_{ij}); /* computing the dominance degree via aggregated dominance values*/
8. Rank the alternatives Q_i via aggregated dominance degree τ_i.
9. Return the best alternative (Q_i).

Step-1: **Construction of decision matrix**:

In this step, we construct the decision matrix concerning the finite set of alternatives and finite set of criteria where the entries of the mentioned decision matrices are all pentagonal neutrosophic numbers. Here P_1, $P2, P_3$ play the role as attributes of corporate, student, and teacher's opinion respectively, and Q_1, $Q2, Q_3$, Q_4 play the role as alternatives namely effectiveness, speed, safety, and ease of use respectively.

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$$D = \begin{pmatrix} . & P_1 & P_2 & P_3 \\ Q_1 & < 0,1.9,5.3,5.9,7.6; 0.6,0.5,0.1 > & < 2.3,3.2,8.3,10.1,28.2; 0.6,0.4,0.2 > & < 2.3,4.7,6.9,9.3,9.5; 0.7,0.2,0.3 > \\ Q_2 & < 0,1.6,6.6,8.8,10.6; 0.8,0.1,0.1 > & < 2.7,3.2,6.7,8.8,17.6; 0.7,0.4,0.2 > & < 2.3,4.2,6.2,7.7,21.8; 0.7,0.2,0.1 > \\ Q_3 & < 0,1.9,4.4,5.8,10.6; 0.7,0.2,0.1 > & < 2.4,3.6,5.8,7.8,20.14; 0.6,0.3,0.3 > & < 2.6,3.5,6.7,8.7,11.9; 0.6,0.3,0.2 > \\ Q_4 & < 0,2.8,2.9,5.3,8.8; 0.4,0.3,0.1 > & < 3.2,3.6,4.5,8.8,14.1; 0.45,0.35,0.3 > & < 2.7,3.5,6.2,8.2,16.4; 0.7,0.3,0.2 > \end{pmatrix}$$

Step-2: **Incorporation of the weight vector:**

In this step, we incorporate a weight vector on the criterion set which is given as follows.

$$\Delta_1=0.35,\ \Delta_2=0.32 \text{ and } \Delta_3=0.33$$

Step-3: **Computation of the relative weight:**

In this step, we compute the relative weight of each criterion by the equation (4) and obtain the following relative weights.

$$\omega_1 = 1, \omega_2 = 0.91, \omega_3 = 0.94$$

Step-4: **Computation of scored valued matrix:**

In this step, we compute the score values of the above-mentioned decision matrix using the formula (2) and obtain the following score-valued matrix.

$$S=\begin{bmatrix} 2.76 & 6.95 & 4.80 \\ 4.78 & 5.46 & 6.75 \\ 3.63 & 5.30 & 4.68 \\ 2.64 & 4.10 & 5.43 \end{bmatrix}$$

Step-5: **Computation of Dominance matrices:**

In this step we construct the dominance matrices in accordance with the mentioned alternatives and criterion using the equation (6).

$$\pi_1 = \begin{bmatrix} 0 & -2.40 & -1.48 \\ 0.84 & 0 & 0.65 \\ 0.55 & -1.85 & 0 \\ -1.39 & -2.58 & -1.80 \end{bmatrix}, \pi_2 = \begin{bmatrix} 0 & 0.74 & 0.75 \\ -2.28 & 0 & 0.14 \\ -2.36 & -1.74 & 0 \\ -3.07 & -2.07 & -2.06 \end{bmatrix}, \pi_3 = \begin{bmatrix} 0 & -3.48 & 0.38 \\ 0.68 & 0 & 0.36 \\ -1.95 & -1.83 & 0 \\ 0.54 & 0.52 & 0.40 \end{bmatrix}$$

Step-6: **Computation of Aggregated Dominance Values:**

In this step we compute the aggregated dominance values of each of the alternative using the equation (7) and obtain the followings.

$$\vartheta(d_1,d_1)=0 \qquad \vartheta(d_1,d_2)=-5.14 \qquad \vartheta(d_1,d_3)=-0.35$$

$$\vartheta(d_2,d_1)=-0.76 \qquad \vartheta(d_2,d_2)=0 \qquad \vartheta(d_2,d_3)=1.15$$

$$\vartheta(d_3,d_1)=-3.76 \qquad \vartheta(d_3,d_2)=-5.42 \qquad \vartheta(d_3,d_3)=0$$

$$\vartheta(d_4,d_1)=-3.92 \qquad \vartheta(d_4,d_2)=-4.13 \qquad \vartheta(d_4,d_3)=-3.46$$

Step-7: **Computation of Dominance Degree:**

In this step, we compute the dominance degree of each of the alternatives using equation (8) and obtain the following.

$$\tau_1 =0.51,\ \tau_2 =1.00,\ \tau_3 = 0.20 \text{ and } \tau_4 = 0.$$

Step-8: **Ranking of the Alternatives:**

In this step, we rank the alternatives following their dominance values. Here

$\tau_2 > \tau_1 > \tau_3 > \tau_4$. So the ranking of the alternatives is $Q_2 > Q_1 > Q_3 > Q_4$.

5.2 Implication:

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The major foundation for a wider influence of chatbots over the last decade has been the advancement of technology. The text user interface gave way to the graphical user interface, then smart phone apps, and finally the conversational interface. The goal of this study was to determine the influence of chatbots, particularly in the banking industry. We wanted to learn more about the benefits of chatbots in banking transactions, as well as the differences between banking via social media and banking via chatbots. When it comes to mathematical computations, the sense of ambiguity is crucial. We sought to verify the system's operation and see how different qualities affected its adoption in chatbot banking in this study. Later on, we pioneered some more intriguing results on the score and exactness functions.
There have been a few different sorts of studies on the use of chatbots in the banking industry. Many of the outcomes, however, are still unknown. Our task is to investigate the following points:

- To define the characteristics essential of Chatbots banking.
- To discover the usefulness of using Chatbots in the Banking Industry.
- Discovering the difference between Mobile Apps and Chatbots and finding the best option for the users.
- The characteristics are used to provide a graphical depiction of chatbot adaption.
- For the selection of social media networks, a pentagonal neutrosophic number related TODIM based MCDM issue was used.

5.3 Discussion:

The purpose of this study was to learn about people's attitudes of using chatbots for banking transactions in West Bengal. Students, employed people, and professionals were interviewed for the study. The difference between Mobile banking and Chatbot Banking was identified by the following 4 different types of attributes, Usability, Speed, Security & Privacy, and Ease of use.

Both academics and banks gained fresh views as a result of the study. This study found that the choice of Chatbot Banking is influenced by a variety of factors, which vary depending on client views.

Men outnumber women in the sample under consideration; the majorities of respondents are under 40 years old and are tech savvy. Young people are dominating the usage of the Internet for banking, as is the case around the world.

The measurement of chatbot banking quality and its consequences has received little attention in the West Bengal banking market. Banks must investigate chatbot banking to please clients, it is acknowledged. Customers will be persuaded to engage with banks on a long-term basis if they receive excellent service. Client loyalty is earned through long-term connectedness and greater customer pleasure.

5.4 Findings:

Customers want three things from banks: better and faster service, a simpler method to go to the bank, and transaction security and privacy. Customers don't want generic commercials and offers; they want products and services that are suited to them, and they are willing to provide personal information in order to get them. A chatbot can welcome a customer when he logs into their account and offers customized help. To give customized offers to the customers, it uses advanced speech, natural language processing, and even sentiment analytics to judge the tone, feel, and voice accent. This kind of personal customers rendezvous can bring customer satisfaction and ultimately improve customer loyalty. Chatbots can add a personal touch while interacting with customers and that gives a fantastic feeling to the customers.
All of the above is attainable if banks adopt chatbots in a systematic manner and maintain sufficient follow-up. As of today, it has been discovered to be the simplest and most responsive method of communicating with clients. The following discoveries were made:

- Chatbots have greater acceptability amongst the young crowd.
- Chatbots have greater acceptability than mobile banking considering all the four attributes
- After the application of Weightage, the Speed attribute is found to be the most important deciding factor in the adaptation of Chatbot banking.
- Usability, Speed, Security, and Ease of Use are four distinct features that have a significant influence on total customer satisfaction, resulting in the adoption of ChatBot in the banking industry.

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- Bank profit margins would be boosted if chatbot tactics were properly implemented. More happy clients would grow the customer base without the need to open new physical locations, resulting in cost savings.
- Chatbots are more spontaneous and easier to use in comparison to a traditional banking app because the download is not required and it can give a personalized experience.

6. Conclusion:

It is possible to infer that chatbots can have a significant impact on and improve the functions performed by banks. According to the findings, practically all of the state's major banks are utilizing chatbots to communicate with consumers in order to provide a more personalized experience. Respondents' major reasons for choosing Chatbots over mobile banking were speed, security and privacy, and simplicity of use, according to the survey. Chatbots were almost universally liked because of their quickness and reduced time waste. In the case of increased security, the majority of respondents indicated that using chatbots for banking transactions would be beneficial. As a result, we may infer that clients are prepared to adopt chatbots in banking transactions if banks ensure their data protection and privacy. Customers in the banking business are ready to use chatbots for a variety of reasons, including curiosity, convenience, and technological development. As a result, banks should consider adopting chatbots to connect with their customers. Because of technological advancements and increased customer understanding, more contact with chatbots is projected to increase. Banks should be ready for this transformation in the future. In the approaching years, chatbot banking is expected to become more appropriate and popular in the banking business. Chatbots are still in their infancy. There is still a lot of research to be done. Launching the chatbots now will not only increase visibility, but it will also serve as a marketing tool to entice new clients. Our next research will include more questionnaires and comments from consumers and banks in order to examine chatbot functioning and recommend methods to enhance it.

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