Impact of Social Media in Banking Sector under Triangular Neutrosophic Arena Using MCGDM Technique

Nidhi Singh[1,2], Avishek Chakraborty[3*], Soma Bose Biswas[4], Malini Majumdar[5]

[1]Registrar, Narula Institute of Technology, Kolkata-700109, W.B, India.

[2]Department of Management, Maulana Abul Kalam Azad University of Technology, West Bengal, Haringhata, Nadia-741249, W.B, India. Email: nidhi.singh@jisgroup.org

[3]Department of Basic Science & Humanities, Narula Institute of Technology, Kolkata-700109, W.B, India.

[4]Heritage Business School, 994, Madurdaha, Chowbaga Road, Anandapur, P.O. East Kolkata Township, Kolkata-700107, West Bengal, India. Email: somabbiswas@gmail.com

[5]Army Institute of Management, Judges Court Road, Alipore, Kolkata 700027. Email: malini_majumdar@hotmail.com

*Corresponding author email address: tirtha.avishek93@gmail.com

Abstract: This paper aims to uncover the position of social media in customer relationship management (CRM) in banking industry in West Bengal (W.B) under neutrosophic environment. It also tries to identify the attributes that influence the adaptation of different social media platforms for marketing by Banks and finally its use in CRM approaches. The scope of this research is, however, limited to the West Bengal (India) state. In this study a qualitative in-depth questionnaire has been used in presence of impreciseness. Three case studies were developed, which explained the adaptation and implementation of social media in retail banks in W.B. The responses, gathered through in-depth interviews with top bank officials and estimated data from official web sites of the banks have been used for MCGDM and sensitivity analysis. Different attributes like Safety & Privacy, Effectiveness & Efficiency and Fulfillment & Responsiveness have a significant impact on the overall service quality perception for Banks using social media and its platforms. We have performed comparative analysis with the established method to find out the best social media platform under neutrosophic environment in WB's banking Industry. Successful implementation of these platforms would then ensure Customer Loyalty and effective CRM. It was also noted that customers mainly refrain from Banking through social media due to safety and privacy concerns. The study was done to suggest betterment of social media marketing performance for banks in WB in presence of uncertainty. It recommended managers to continuously monitor the overall service quality of social media platforms as they lead to customer loyalty and CRM.

Keywords: West Bengal, Social media, Customer loyalty, Service quality, Customer Relationship Management, Neutrosophic, CRM, Retail banking.

1. INTRODUCTION:

1.1. SOCIAL MEDIA: Social Media is a communication platform that facilitates communication via virtual networks. It is a virtual medium which is designed to aid people to share contents, pictures, videos, and views swiftly and in real-time through websites and applications. The ability to share photos, opinions, events, etc instantaneously has transformed the way we communicate and, also, the way we do business. It provides the facility of continuously communicating with a large number of people at a time. The revolution of Social media and its increasing impact has transformed its old conventional image of amusement to an opportunity to work and trade. This vibrant use of social media has affected almost every business sectors either positively or negatively. It has changed the way business was done and Marketing has taken a new shift after this. Social media offers different ways to promote business either through organic marketing (free) or by paid marketing. Web 2.0 technologies are the stage of Internet expansion where static web pages were converted to user generated content [1]. The business communication is enhanced to a new height via online mode through Social media [2]. According to [3] People share a lot of information about their personal lives, their needs and preferences on social media and it may assist the institutions to design their marketing policies. Based on the above data it can be said that the social media set-up facilitate in building virtual group for individuals with similar mind-set, hobbies, work culture etc [4]. Therefore, use of social networking could assist Banks build up their brand awareness and brand loyalty which ultimately help in customer acquirement and retention [5]. Communication between clients and Banks has improved a lot after successful implementation of Internet mainly because it has eliminated geographical hindrances [6]. Now it has almost become mandatory for all the banks to adapt social media for getting customer loyalty and effective CRM.

1.2. **Social media statistics in India:** India is the 2nd largest country in the world in terms of Population with over 1.36 billion people.

- India currently has a population of 1,369,566,180 - this is 17.1% of the world's total population
- Median age is 27.1 years - it's a young country
- Life expectancy is 69 years
- Internet penetration is low in India - yet, in December 2018, 566 million users were online in India. Out of this - 493 million are regular users of the internet. (source: livemint).
- At the end of 2018, the number of social media users in India stood at 326.1 million. (statista)
- At the end of 2019, this number has been estimated to grow to 351.4 million.
- On average, Indian users spend 2.4 hours on social media a day (slightly below the global average of 2.5 hours a day). (Source: The Hindu)
- 290 million active social media users in India access social networks through their mobile devices. (Source: Hootsuite)
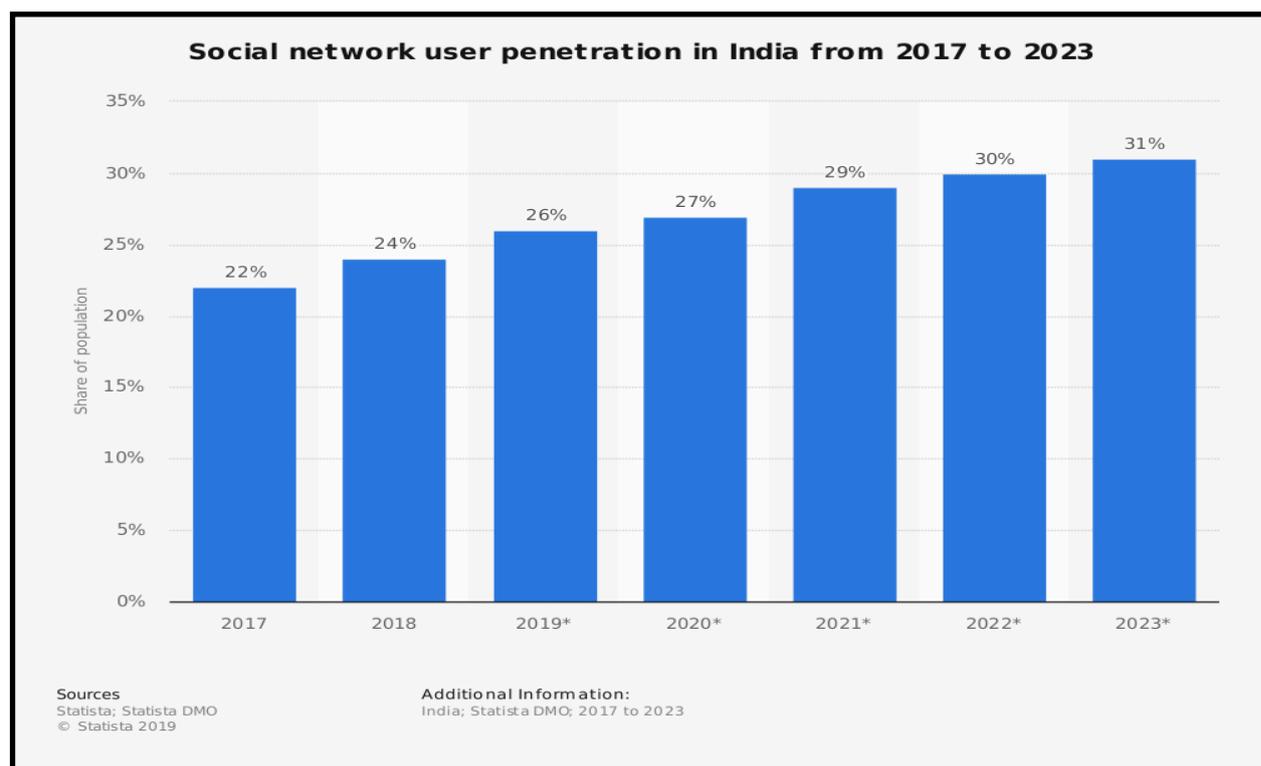
India: social network penetration 2017-2023

Based on customer's requirement and rapid market the number of social media sites is increasing day by day to cater to the needs of different audience groups. Before choosing social media platform, it is essential for banks to realize the available social media platforms and location of their customer base in these Medias. Some of the social media categories are as follows:
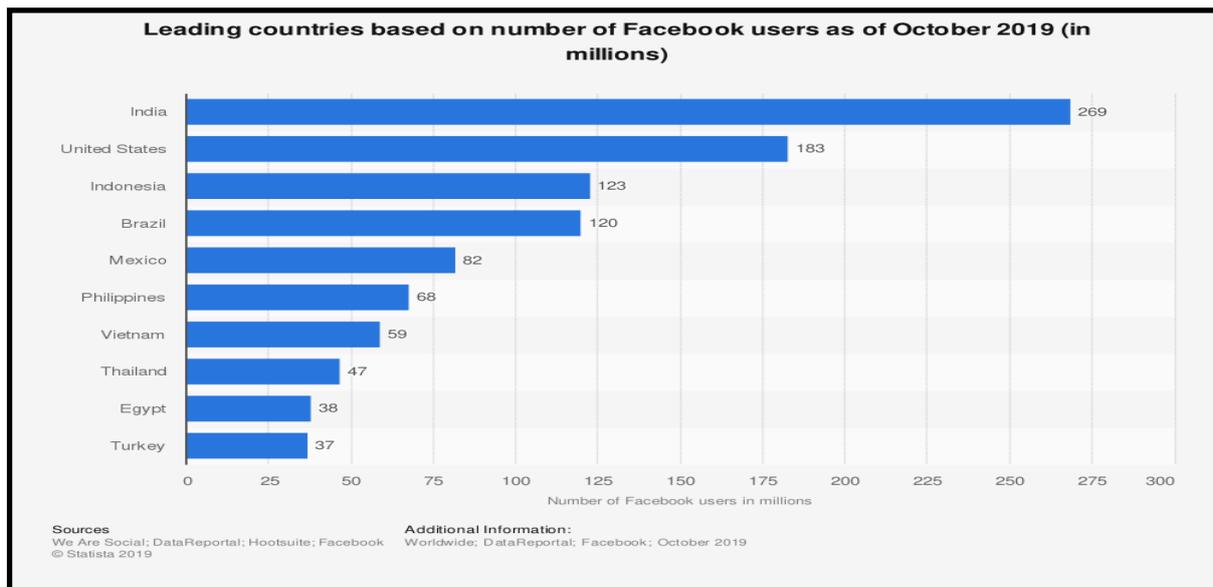
1.2.1 Communities and social groups:

"We build technologies to give people the power to connect with friends and family, find communities and grow businesses"- face book

These sites allow connecting people of similar interests and background. This is used to share information and events to large number of customers and building relationship by regular interaction. Banks may also pose their brand on social network as an expert information source. This may also be used for educating and training customers regarding different products and services provided by banks.

Face book Statistics in India:

- India ranks first in terms of face book users. Currently is has 269 million active users in India (Source: Investopedia)
- The largest user group by age on Face book is 18-24 years, with a massive 97.2 million users.

Leading countries based on number of Facebook users as of October 2019 (in millions)

Sources
We Are Social; DataReportal; Hootsuite; Facebook
© Statista 2019

Additional Information:
Worldwide; DataReportal; Facebook; October 2019

Face book usage penetration in India from 2015 to 2023

Messaging and communication: (e.g. blogging and micro-blogging such as Twitter):

"Follow everything from breaking news and entertainment, to sports, politics, and everyday interests. Then, join the conversation"- Twitter

Blogging and Micro Blogging are used for creating online communities where customers can seek out information and answers to their questions. It is used to listen and resolve customer queries/issues in banking world. It creates a vast online, viral, and word of mouth, which is optimal for establishing brand loyalty and monitoring reputation.

Twitter Statistics in India:

- India has 7.75 million users on Twitter. (Source: statista)
- 18% of social media users in India look at Twitter as a source of news. (Source: Reuters)
- Twitter usage unlike other platforms is actually decreasing = 2.2% per quarter (Source: Digital 2019 report from Hootsuite)
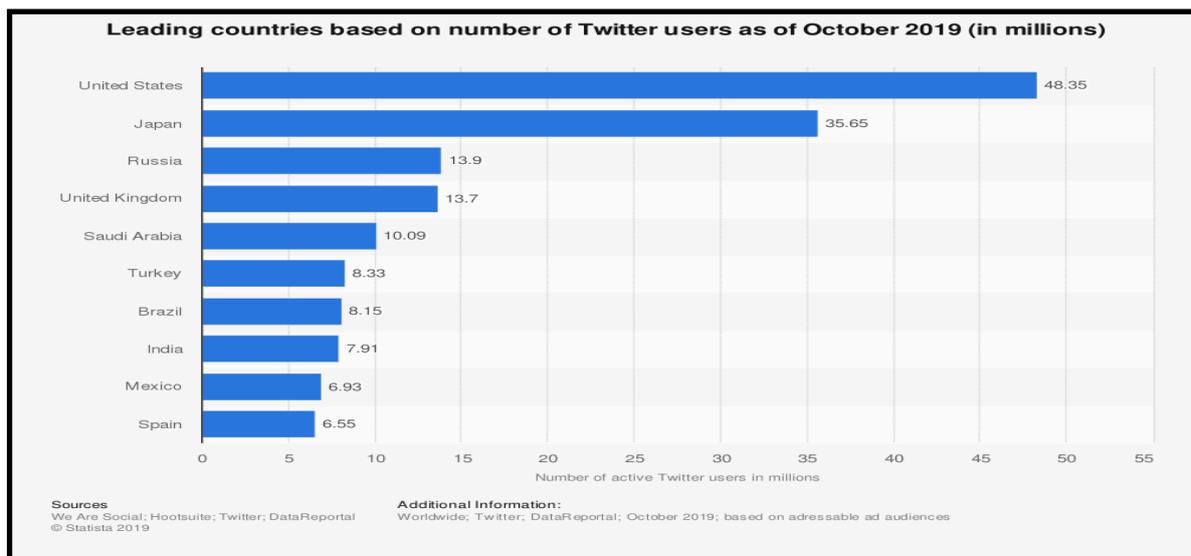
Content Communities: (Photo and video sharing, e.g. YouTube):

"Enjoy the videos and music you love, upload original content, and share it all with friends, family, and the world" – YouTube. They are content specific. These could be used for brand promotion, engaging customer through sharing pictures, videos etc.

You Tube statistics in India

- As per Google announcement, as of August 2018, there were 245 million active You Tube users in India.
- This figure is predicted to double over the next two years.
- Online video accounts for 75% of data traffic in the country – and with 4G networks improving; this is likely to further increase.
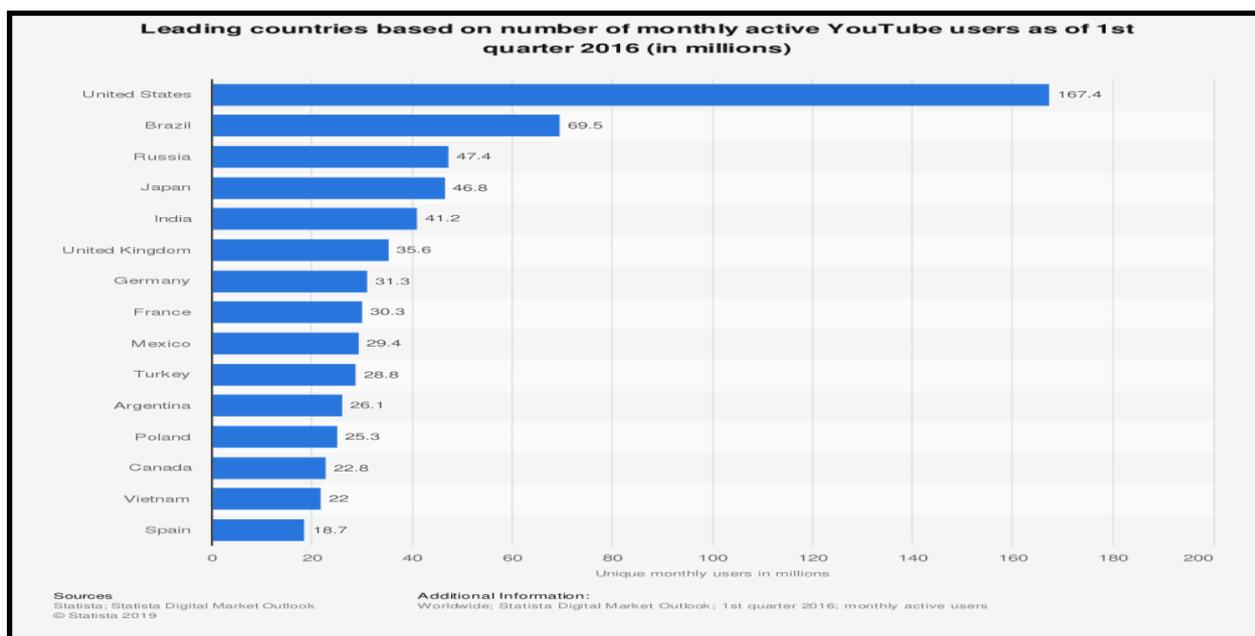
The literature on the banking sector has abundant references to online and electronic services (e.g. e-banking), but has paid relatively little attention to the adoption and use of social media [7-9].

1.3. BANKING AND SOCIAL MEDIA

Banking sector is the backbone of any emerging economy. Banks are instrumental in implementing the economic reforms. Any revolution in the banking sector because of the acceptance of technology is bound to have a broad impact on an economy's growth. These days, banks are seeking unconventional ways to provide and differentiate amongst their various services. Customers now demand a facility to conduct their banking activities at any time and place according to their convenience [10].

Banking sector is the backbone of any emerging economy. Banks are instrumental in implementing the economic reforms. Any revolution in the banking sector because of the acceptance of technology is bound to have a broad impact on an economy's growth. These days, banks are seeking unconventional ways to provide and differentiate amongst their various services. Customers now demand a facility to conduct their banking activities at any time and place according to their convenience [11].

Social media has changed the entire gamut of business and marketing and Banking Industry is no exception to this because here the Customer Interaction is a must. Today Social media is universal and pervasive, so banks can rely on it. Digital communication is becoming a strong communication medium between Banks and customers. This media is proving itself indispensable in connecting to the potential clients. By allowing transfer of money, getting credit and even simply opening a bank account, it has improved customer services which in turn are improving the customer relationship. Assessing people's sentiments is a very significant and staggering job, particularly in case of service industry. Social media has a unique ability to create and sustain associations with customers, creating better Customer relations. Hence banks need to consider social media as an integral part of their overall marketing strategy [12].

People use Face book, Twitter, YouTube, Instagram, LinkedIn etc to understand different information regarding the different products and services provided by banks only after understanding the facilities and prospects of various social media platforms. Banks are using this network to inform their customers about their products and upgrade them according to customers' feedback. On the other hand, there is the talk of turnover in social networks. Also, purchases can be made through social networks.

Physical Banking opted tactics like advertising, direct mail or face to face communication for customer interaction so far but now the approaches have changed from providing customer service to affiliation and long term relationship with customers. For doing it, banks need to diagnose customers' interests, emotions and behavior and with help of social media this analysis are being done easily. Today, customers expect that they should be heard and answered and receive the services they need through social media.

Social Medias can greatly affect the reputation and the brand image of the banks. Banks need a transparent understanding of the key elements in the development of social media and adopt a road

map and a strategy. The banks may use the following pathway in social media to listen to the customers.

- **As Is:** Banks need to understand the customers' requirements initially by analyzing their data in social networks.
- **Listen:** The next step would be to analyze the data carefully. Then the bank should design and provide support as per their expectation,
- **Engage:** Information can be collected through customers and through feedback taken Bank's can fulfill the customers' needs.
- **Optimize:** In the last step bank should attract fans and increase the loyalty of existing customers by using customers' feedback and analyzing their interactions with each other.

In a media landscape increasingly dominated by social media, Bank's marketing strategy for these platforms can make or break its success as a brand. Banks need to hold their social media efforts to high standard, creating custom made strategies that build their brand, win customers, and yield high ROI. Therefore social media techniques have become essential communication tools for banks to communicate with people across globe. Banks are adapting social media because they are finding it difficult to fight with traditional banking methods such as interest rates and product differentiation to attract new clients and sustain the existing ones. In today's aggressive atmosphere customer loyalty can be gained through allocation of finer service quality to ensure maximum customer satisfaction [13].The purpose of this study is thus, to explore the implication of social media on service quality perception and client loyalty in the banking industry of West Bengal. Social media service quality can be used to boost customers' loyalty by Banks in the India banking industry [14]. There are limited studies on social media service quality and client loyalty for Indian Banking industry. This study will contribute towards reducing the knowledge gap between impact of social media on service quality and customers' loyalty. These attributes so discussed would be able to improve the quality of social media performance.

The article is structured as follows: The next section will provide a discussion on the use of social media in the Indian banking industry, followed by a discussion on the methodology that was used for data collection, and a presentation of the results. The last section provides the study's findings and conclusion.

2. Literature Review: Indian Banks have started using social media in their regular operations in various capacities a little lately and are at different stages of maturity. As of April 2013, some private banks provide regular updates on the latest offers and allow basic customer operations through popular social media sites. A large private bank in India hosted Face book application on its secure servers allowing balance amount check, cheque book request, stop payment, etc. Some of the private banks are using their social media websites to provide their customers, distinct offers, detailed product information and consumer care services. With some banks taking the lead by setting

example, the others also have started following their footsteps. In a survey by the Financial Brand newsletter in July 2013, it was established that ICICI, Axis and HDFC Banks are among the top 10 Banks with Social Media presence. Of late public sector banks have also started using this media in a grand way. As per present scenario, Indian banks can no longer live in denial by avoiding and not using Social Media if they do not want threatening their own business. The Indian banking industry has envisaged some social media channels to attract tech-savvy clients and improve customer services to bring customer loyalty [15]. The use of social media in India has gained its importance.

2.1 Social Media Safety & Privacy: Privacy refers to the extent by which the customers' details are protected by bank's social media platform [16].Banks need to give their customers enough confidence to use their social media accounts so that they may perceive that their personal information will be secured and not to be misused by banks [17]. Banks can build new healthy relationship with customers if the privacy is perceived positively by customers [18]. The information get disclosed and shared through social media so easily, that it has raised doubts about its privacy among the users [19]. Maintenance of privacy in bank's social media channel has been a big challenge for the banking industry. The main challenge is to monitor and control the posts in these sites [20]. A proper privacy setting of social media site is very essential in banks because privacy invasion may lead to theft of personal identification and may lead to criminal proceedings. In case of low security features hackers may hack the social media sites and/or may clone the original, befooling customers and duping them [21].

2.2 Social Media Efficiency & Effectiveness: Effectiveness refers to the ease of use, internet speed, expediency etc with which customers may access and use bank's social media sites [22]. Effectiveness measures the efficiency of bank's social media and it estimates the speed of accessing and working on the bank's social media sites to ensure timely and convenient completion of all required interaction [23]. Social media can augment the conventional personnel–client bonding with an effective technological knowledge-based relationship [24].

Today's customers need prompt responses and it can effectively be done in social media by providing them relevant and quick information as & when required. It is surely required for enhancement of quick responses to customers' queries for the improvement of e-services and clients' improved customer satisfaction [25]. Banks can provide unique banking experience to their clients by giving them services combined with technology. Hence the primary task of the bank is to find out and respond to customers' queries effectively on Bank's social media sites. By monitoring the response of bank personnel on social media sites, Banks need to assess the service quality. As per the above discussion we can make the following hypothesis:

2.3 Social Media Fulfillment & Responsiveness: Fulfillment concentrate on the service truthfulness and ease of use of relevant information provided on a bank's social media websites [26]. Customers need prompt response and acknowledgement of their complaints or suggestions. The fulfillment dimension concentrates on evaluating the banks promptness in responding to customers' requirements [27]. For getting customer loyalty the banks create user generated customized content

for getting the Fulfillment dimension [28]. Hence Fulfillment refers to the customer's confidence on Bank's social media platform to the extent their requirements are fulfilled.

2.4 Theory of Vagueness and Multi-Criteria Decision-Making Problem (MCDM): Due to the complication of detached things and hesitation in human thinking, [29] manifested a remarkable perception of neutrosophic set theory, which has been widely applied on disjunctive arenas of science and engineering. Recently, researchers developed pentagonal [30], Hexagonal [31], Heptagonal [32] fuzzy numbers in research domain. Researchers also established some useful techniques [33-35] which linked the hesitant number and the crisp number in real life scenario. In this era, MCDM is the paramount topic in decision scientific research. Recently, it is more essential in such problems where a group of criteria is apprised. For such problems involving multi-criteria group, decision-making problems (MCGDM) have come into existence. In this current epoch, several works has been already published in this arena. [36] Introduced MCDM skill in Pythagorean fuzzy set field, [37] focused on linguistic aggregation operators based on MCGDM problem, [38] surveyed intuitionistic interval fuzzy information and applied it in MCGDM problem, [39] derived MCGDM methodology using type-2 neutrosophic linguistic judgments, [40] manifested the idea of MCGDM in human resource development arena, [41] developed MCGDM skill in thermal enovation of masonry buildings field,[42] introduced best-Worst-Method and ELECTRE Method using MCGDM, [43] applied MCGDM in garage location selection based civil engineering problems, [44] derived decision making method in intuitionistic neutrosophic environment, [45] utilized MCDM in bipolar neutrosophic set arena, [46] wielded MCGDM in entropy based problem, [47] used MCGDM in smart phone selection problem, [48] developed MCGDM in selection of advanced manufacturing technology in neutrosophic set, [49] derived attribute based MCDM in linguistic variable in intuitionistic fuzzy set.

Motivated by Smarandache's neutrosophic theory [52], researchers established several articles [53-62] in this domain and it is fruitfully applied in various field of mathematics. Also, a few new techniques are manifested in neutrosophic theory which can grab and solve MCDM, MCGDM problems in disjunctive domain. In this phenomenon, Vikor [63], TOPSIS [64], MOORA [65], GRA [66] skills are developed to solve decision making problems using some suitable and logical operators in neutrosophic theory. So, in case of social science related hesitant data, decision making problem becomes one of the key topics in neutrosophic ambient.

In this research article, we consider a triangular neutrosophic based MCGDM technique to select the best social media for online marketing in banking sector. Here, we collect all the information's from different banks based on their online marketing report. But, we observed that these data's 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 triangular neutrosophic number to tackle this system for better results. Additionally, we also incorporate different weights in distinct attribute functions as well as decision maker's choice. Finally, we performed a sensitivity analysis and comparative study which reflects different case studies in disjunctive scenario.
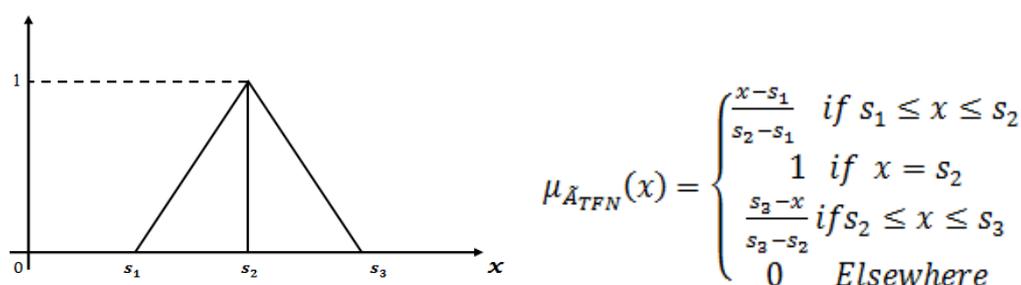
2.5 Preliminaries:

Definition 2.5.1: Fuzzy Set: A set $\tilde{F}$, generally defined as $\tilde{F} = \left\{ \left(\alpha, \mu_{\tilde{F}}(\alpha) \right) : \alpha \in S, \mu_{\tilde{F}}(\alpha) \in [0,1] \right\}$, denoted by the pair $\left(\alpha, \mu_{\tilde{F}}(\alpha) \right)$, where α belongs to the crisp set F and $\mu_{S}(\alpha)$ belongs to the interval $[0, 1]$, then set $\tilde{S}$ is called a fuzzy set.

Definition 2.5.2: Triangular Fuzzy Number: A triangular fuzzy number $\tilde{A} = (s_1, s_2, s_3)$ should satisfy the following condition

(1) $\mu_{\tilde{A}}(x)$ is a continuous function which is in the interval $[0,1]$
(2) $\mu_{\tilde{A}}(x)$ is strictly increasing and continuous function on the intervals $[s_1, s_2]$.
(3) $\mu_{\tilde{A}}(x)$ is strictly decreasing and continuous function on the intervals $[s_2, s_3]$.

Definition 2.5.3: Linear Triangular Fuzzy Number (TFN): A linear triangular fuzzy number can be written as $\tilde{A}_{TFN} = (s_1, s_2, s_3)$ whose membership function is defined as follows:

$$\mu_{\tilde{A}_{TFN}}(x) = \begin{cases} \frac{x - s_1}{s_2 - s_1} & if \ s_1 \leq x \leq s_2 \\ 1 & if \ x = s_2 \\ \frac{s_3 - x}{s_3 - s_2} & if \ s_2 \leq x \leq s_3 \\ 0 & Elsewhere \end{cases}$$

Figure 2.5.3.1: Graphical Representation of Linear Triangular Fuzzy Number

Definition 2.5.4: Neutrosophic Set: [52] A set $\widetilde{neuS}$ in the universal discourse X, symbolically denoted by x, it is called a neutrosophic set if $\widetilde{neuS} = \{\langle x; [T_{\widetilde{neuS}}(x), I_{\widetilde{neuS}}(x), F_{\widetilde{neuS}}(x)] \rangle : x \in X\}$, where $T_{\widetilde{neuS}}(x): X \rightarrow]-0,1+[$ is said to be the true membership function, which has the degree of belongingness, $I_{\widetilde{neuS}}(x): X \rightarrow]-0,1+[$ is said to be the indeterminacy membership, having degree of uncertainty, and $F_{\widetilde{neuS}}(x): X \rightarrow]-0,1+[$ is said to be the incorrect membership, which has the degree of non-belongingness of the decision maker. $T_{\widetilde{neuS}}(x), I_{\widetilde{neuS}}(x) \& F_{\widetilde{neuS}}(x)$ exhibits the following relation:

$$-0 \leq Sup\{T_{\widetilde{neuS}}(x)\} + Sup\{I_{\widetilde{neuS}}(x)\} + Sup\{F_{\widetilde{neuS}}(x)\} \leq 3+.$$

2.5.5: Triangular Single Valued Neutrosophic number: [33] A Triangular Single Valued Neutrosophic number is defined as $\tilde{A}_{Neu} = (p_1, p_2, p_3; q_1, q_2, q_3; r_1, r_2, r_3)$ whose truth membership, indeterminacy and falsity membership is defined as follows:

$$T_{\tilde{A}_{Neu}}(x) = \begin{cases} \frac{x-p_1}{p_2-p_1} & when\ p_1 \le x < p_2 \\ 1 & when\ x = p_2 \\ \frac{p_3-x}{p_3-p_2} & when\ p_2 < x \le p_3 \\ 0 & otherwise \end{cases}, \qquad I_{\tilde{A}_{Neu}}(x) = \begin{cases} \frac{q_2-x}{q_2-q_1} & when\ q_1 \le x < q_2 \\ 0 & when\ x = q_2 \\ \frac{x-q_2}{q_3-q_2} & when\ q_2 < x \le q_3 \\ 1 & otherwise \end{cases}$$

$$F_{\tilde{A}_{Neu}}(x) = \begin{cases} \frac{r_2-x}{r_2-r_1} & when\ r_1 \le x < r_2 \\ 0 & when\ x = r_2 \\ \frac{x-r_2}{r_3-r_2} & when\ r_2 < x \le r_3 \\ 1 & otherwise \end{cases}$$

Where, $0 \le T_{\tilde{A}_{Neu}}(x) + I_{\tilde{A}_{Neu}}(x) + F_{\tilde{A}_{Neu}}(x) \le 3,\ x \in \tilde{A}_{Neu}$

2.5.6: Score Function: [50] If $\tilde{A}_{Neu} = (p_1, p_2, p_3; \pi, \rho, \sigma)$ be a triangular neutrosophic number then its score function is defined as $S_C = \frac{1}{8}(p_1 + p_2 + p_3) \times (2 + \pi - \rho - \sigma)$ and accuracy value is defined as,

$$A_C = \frac{1}{8}(p_1 + p_2 + p_3) \times (2 + \pi - \rho + \sigma)$$

3. Purpose/ Objectives of the Study:

1. To understand the factors affecting the customers' attitude towards acceptance of Social Media Channels,
2. To help Banks understand the impact of Social Media Channels on customer satisfaction and customer loyalty.

4. Research Methodology:

The data have been collected from various respondents working in different organizations categorized mainly as education sector, service sectors as banks, hospitals, etc. engineering works and Government and Public sector companies in the Kolkata metro area. The study consisted of 234 respondents whose income is above 15,000 per month as it is assumed that those people at least above Rs. 15000 earning/ month will be transacting more through online mode and can afford a smart phone. We have used a five point Likert scale where 5 indicates strongly agree, and 1 indicates strongly disagree. 64.9% respondents are male and 35.1% are female.

Research Instrument: Demographic Profile is the independent variable in this paper. Technology acceptance model by Ajzen & Fishbein, 1980, Davis, 1989 and Ajzen, 1991 are used for validating questionnaire. The questionnaire is mainly focused on: Social Media platforms used by the banks and attributes affecting the users' adaptability of the same.

TABLE 4.1.1 DEMOGRAPPHIC DETAILS OF RESPONDENTS			
CHARACTERISTICS	**TYPES**	**FREQUENCY**	**%**
GENDER	MALE	135	57.69
	FEMALE	99	42.31

AGE	<25	75	32.05
	25-40	154	65.81
	>40	5	02.14
OCCUPATION	EMPLOYED	92	39.32
	UNEMPLOYED	22	9.40
	PROFESSIONAL	14	5.98
	STUDENT	95	40.60
	BUSINESS	10	4.27
	OTHERS	1	0.43
SOCIAL MEDIA PLATFORM	FACEBOOK	132	56.41
	TWITTER	47	20.09
	YOUTUBE	55	23.50
HOURS OF SURFING THROUGH SOCIAL MEDIA	DAILY	149	63.68
	WEEKLY	13	5.55
	MONTHLY	6	2.56
	VERY RARE	66	28.21

Table 4.1.2 Indicate acceptance of Social Media based on various attributes				
BANK	**PLATFORM**	**SAFETY & PRIVACY (%)**	**EFFICIENCY & EFFECTIVENESS (%)**	**FULFILLMENT & RESPONSIVENESS (%)**
1	FACEBOOK	10	65	54
	TWITTER	6	16	50
	YOUTUBE	5	26	28
2	FACEBOOK	15	76	56
	TWITTER	12	37	26
	YOUTUBE	21	24	15
3	FACEBOOK	23	29	45
	TWITTER	13	15	16
	YOUTUBE	45	9	7

4.1 Multi-Criteria Group Decision Making Problem in Triangular Neutrosophic Environment

One of the most dependable, logistical and widely used topic in this recent era is Multi criteria decision making problem. Its main objective is to find out the finest option among finite number of different alternatives based on finite unlike attribute values. Its execution process was quiet tough to estimate in triangular neutrosophic environment. To handle this MCGDM problem an algorithm was developed using some mathematical operator and de-fuzzification technique.

4.1.1 Illustration of the MCGDM problem

We consider the problem as follows:

Let $P = \{ P_1, P_2, P_3 \ldots \ldots \ldots P_m \}$ is the distinct alternative set and $R = \{ R_1, R_2, R_3 \ldots \ldots \ldots R_n \}$ is the distinct attribute set respectively. Let $\omega = \{ \omega_1, \omega_2, \omega_3 \ldots \ldots \ldots \omega_n \}$ be the weight set associated with the attributes R where each $\omega \geq 0$ and also satisfies the relation $\sum_{i=1}^{n} \omega_i = 1$. We also consider the set of decision maker $D = \{ D_1, D_2, D_3 \ldots \ldots \ldots D_K \}$ associated with alternatives whose weight vector is defined as $\Delta = \{\Delta_1, \Delta_2, \Delta_3 \ldots \ldots \ldots \Delta_k \}$ where each $\Delta_i \geq 0$ and also satisfies the relation $\sum_{i=1}^{k} \Delta_i = 1$.

4.1.2 Normalisation Algorithm of MCGDM Problem:

Step 1: Framework of Decision Matrices

Here, we considered all decision matrices according to the decision maker's choice related with finite alternatives and finite attribute functions. It is noted that the member's y_{ij} for each matrices are of triangular neutrosophic numbers. Thus, the final matrix is defined as follows:

$$X^K = \begin{pmatrix} . & R_1 & R_2 & R_3 & . & . & . & R_n \\ P_1 & y_{11}^k & y_{12}^k & y_{13}^k & . & .. & . & y_{1n}^k \\ P_2 & y_{21}^k & y_{22}^k & y_{23}^k & . & . & . & y_{2n}^k \\ P_3 & . & . & . & . & . & . & . \\ . & \vdots & . & . & . & . & . & . \\ P_m & y_{m1}^k & y_{m2}^k & y_{m3}^k & . & . & . & y_{mn}^k \end{pmatrix} \ldots\ldots\ldots\ldots\ldots..(4.1)$$

Step 2: Framework of normalised matrix

To formulate a single group decision matrix X we utilized this logical operation $y_{ij}^{'} = \{\sum_{i=1}^{k} \omega_i X^i\}$ for individual decision matrix X^i. hence, the final matrix becomes as follows:

$$X = \begin{pmatrix} . & R_1 & R_2 & R_3 & . & . & . & R_n \\ P_1 & y_{11}^{'} & y_{12}^{'} & y_{13}^{'} & . & .. & . & y_{1n}^{'} \\ P_2 & y_{21}^{'} & y_{22}^{'} & y_{23}^{'} & . & . & . & y_{2n}^{'} \\ P_3 & . & . & . & . & . & . & . \\ . & \vdots & . & . & . & . & . & . \\ P_m & y_{m1}^{'} & y_{m2}^{'} & y_{m3}^{'} & . & . & . & y_{mn}^{'} \end{pmatrix} \ldots\ldots\ldots\ldots\ldots.(4.2)$$

**Step 3: Framework of Final matrix**

To formulate the final decision matrix we utilized the logical operation $y_{ij}^{''} = \{ \sum_{i=1}^{n} \Delta_i y_{ci}^{'} , c = 1,2 \ldots. m\}$ for each individual Colum and finally, we get the decision matrix as,

$$X = \begin{pmatrix} . & R_1 \\ P_1 & y_{11}'' \\ P_2 & y_{21}'' \\ . & . \\ . & . \\ P_m & y_{m1}'' \end{pmatrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots (4.3)$$

Step 4: Ranking

Now, by considering the score and accuracy value (2.5.6) and converting the matrix (4.3) into crisp form, so that we could evaluate the best alternative corresponding to the best attributes.

4.1.3 Flowchart:
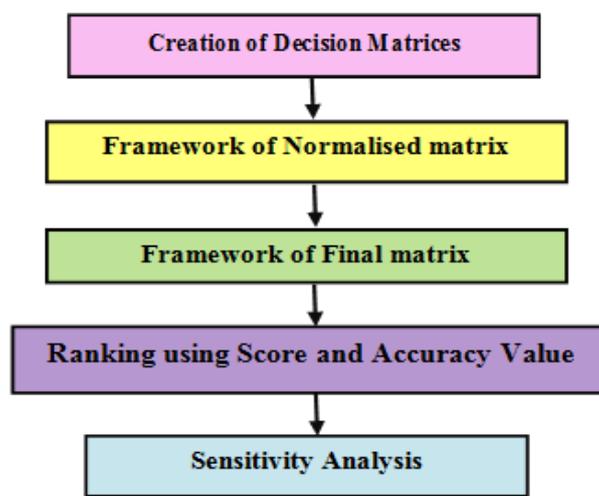
Figure 4.1.3.1: Flowchart for the problem

4.1.4 Illustrative Example:

Here, we constructed a social media selection problem in which we have considered three different social media services. Among these different social media platforms we want to select the best social media service in a logical way. Normally, social media services are fully dependent on the attributes like Safety & Privacy, efficiency & effectiveness and fulfilment & responsiveness of the system. Keeping these points in mind different banks provided some realistic information in which vagueness was present. Thus, we considered the data in the form of triangular neutrosophic number and according to their suggestions we constructed the distinct decision matrices in triangular neutrosophic environment as shows below: $P_1 = Facebook, P_2 = Twitter, P_3 = Youtube$ are the alternatives. $R_1 = Safety \& Privacy, R_2 = Efficiency \& Effectivness , R_3 = Fulfillment \& Reponsiveness$ are the attributes.

Let us select four distinct decision makers from our environment, $D_1 = Bank\ 1, D_2 = Bank\ 2, D_3 = Bank\ 3$ having weight distribution $D = \{ 0.35, 0.33, 0.32 \}$ and the weight vector related with the attribute function $\Delta = \{0.32, 0.35, 0.33\}$.

Step 1

According to the decision maker's opinion the decision matrices are shown as follows:

$$D^1 = \begin{pmatrix} . & R_1 & R_2 & R_3 \\ P_1 & <8.5,10,11; 0.8,0.5,0.4> & <62,65,67; 0.7,0.4,0.5> & <51,54,57; 0.6,0.5,0.5> \\ P_2 & <3,6,8; 0.6,0.4,0.5> & <13,16,18; 0.7,0.3,0.4> & <47,50,54; 0.5,0.2,0.3> \\ P_3 & <3,5,7; 0.5,0.3,0.2> & <23,26,30; 0.6,0.3,0.4> & <24,28,30; 0.4,0.6,0.7> \end{pmatrix}$$

Bank 1 opinion

$$D^2 = \begin{pmatrix} . & R_1 & R_2 & R_3 \\ P_1 & <12,15,17; 0.6,0.4,0.3> & <72,76,79; 0.5,0.6,0.4> & <53,56,60; 0.6,0.4,0.5> \\ P_2 & <10,12,15; 0.5,0.4,0.3> & <35,37,39; 0.5,0.2,0.3> & <24,26,29; 0.5,0.4,0.5> \\ P_3 & <18,21,25; 0.5,0.6,0.4> & <21,24,27; 0.5,0.3,0.4> & <11,15,18; 0.8,0.5,0.4> \end{pmatrix}$$

Bank 2 opinion

$$D^3 = \begin{pmatrix} . & R_1 & R_2 & R_3 \\ P_1 & <21,23,25; 0.6,0.4,0.5> & <26,29,31; 0.6,0.4,0.5> & <41,45,47; 0.7,0.3,0.2> \\ P_2 & <10,13,17; 0.5,0.2,0.3> & <12,15,19; 0.7,0.5,0.5> & <14,16,18; 0.8,0.5,0.4> \\ P_3 & <42,45,49; 0.6,0.4,0.5> & <6,9,13; 0.6,0.4,0.5> & <5,7,10; 0.4,0.2,0.3> \end{pmatrix}$$

Bank 3 opinion

Step 2: Framework of Normalised decision matrix

$$M = \begin{pmatrix} . & R_1 & R_2 & R_3 \\ P_1 & <13.65,15.81,17.46; 0.8,0.4,0.3> & <53.78,57.11,59.44; 0.7,0.4,0.4> & <48.46,51.78,54.79; 0.7,0.3,0.2> \\ P_2 & <7.55,10.22,13.19; 0.6,0.2,0.3> & <19.94,22.61,25.25; 0.7,0.2,0.3> & <28.85,31.2,34.23; 0.8,0.2,0.3> \\ P_3 & <20.43,23.08,26.38; 0.6,0.3,0.2> & <16.9,19.9,23.57; 0.6,0.3,0.4> & <13.63,16.99,19.64; 0.8,0.2,0.3> \end{pmatrix}$$

Step 3: Framework of Final matrix

$$M = \begin{pmatrix} <39.18,42.13,44.47; 0.74,0.36,0.26> \\ <18.92,21.48,24.35; 0.68,0.2,0.3> \\ <16.95,19.96,23.17; 0.7,0.25,0.32> \end{pmatrix}$$

Step 4: Ranking

Now, we consider the score and Accuracy function technique (2.5.6), to convert the triangular neutrosophic numbers into crisp one, thus we get the final ideal decision matrix as

$$M = \begin{pmatrix} <33.34> \\ <17.65> \\ <16.01> \end{pmatrix}$$

Thus, ranking of the social media service is as $P_1 > P_2 > P_3$.

4.1.5 Results and Sensitivity Analysis

To understand how the attribute weights of each criterion affecting the relative matrix and their ranking a sensitivity analysis is done. The basic idea of sensitivity analysis is to exchange weights of the attribute values keeping the rest of the terms are fixed. The below table is the evaluation table which shows the sensitivity results.

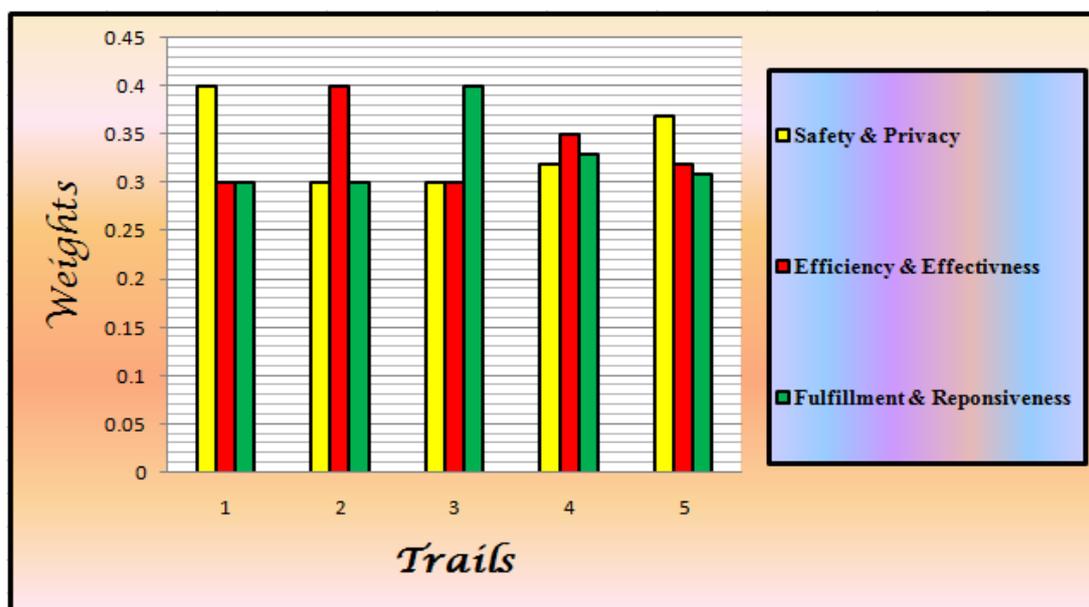| Attribute Weight	Final Decision Matrix	Ordering
$<(0.4, 0.3, 0.3)>$	$\begin{pmatrix} <28.26> \\ <15.56> \\ <14.42> \end{pmatrix}$	$P_1 > P_2 > P_3$
$<(0.3, 0.4, 0.3)>$	$\begin{pmatrix} <31.45> \\ <16.42> \\ <16.20> \end{pmatrix}$	$P_1 > P_2 > P_3$
$<(0.3, 0.3, 0.4)>$	$\begin{pmatrix} <30.54> \\ <16.44> \\ <17.30> \end{pmatrix}$	$P_1 > P_3 > P_2$
$<(0.32, 0.35, 0.33)>$	$\begin{pmatrix} <33.34> \\ <17.65> \\ <16.01> \end{pmatrix}$	$P_1 > P_2 > P_3$
$<(0.37, 0.32, 0.31)>$	$\begin{pmatrix} <35.62> \\ <16.23> \\ <15.45> \end{pmatrix}$	$P_1 > P_2 > P_3$

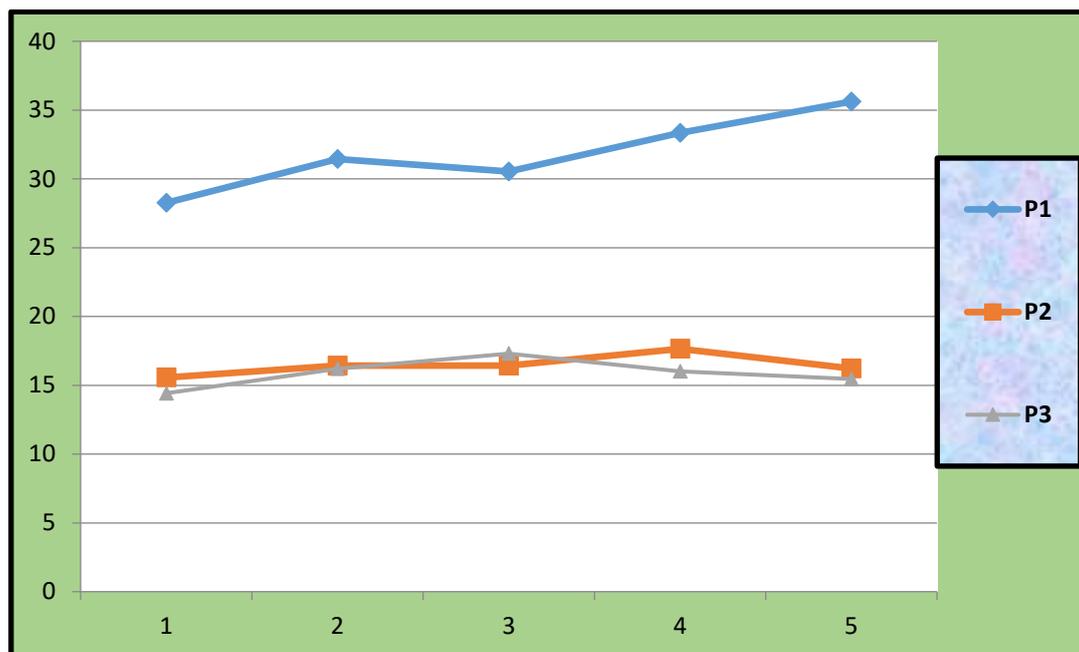**Figure 4.1.5.1: Sensitivity analysis table on attribute function.**

Figure 4.1.5.2: Best Alternative Social Media Service Table

4.1.6 Comparison Table

We compared this proposed work with the established works proposed by the researchers to find the best social media and it is noticed that in each cases P_1 (facebook) becomes the best social media service. The comparison table given as follows:

Approach	Ranking
(Deli, Ali, & Smarandache, 2015) [51]	$P_1 > P_2 > P_3$
(H.Garg, 2016) [36]	$P_1 > P_3 > P_2$
Our Proposed	$P_1 > P_2 > P_3$

5. Implication:

There are a lot of social media sites like face book, twitter, Google plus, linked in, you tube etc. available for online marketing. This study was primarily done to identify the impact of social media marketing especially in Banking Industry based on different social media attributes. We wanted to discover the right social media platform best suited for Banking Industry in West Bengal. The perception of vagueness plays a vital role in designing mathematical calculations. In this study we wanted to check the functionality of this system to find out the impact of different social media

attributes on its acceptance in Online banking system in WB. Later we pioneered some more fascinating outcome on score and exactness function.

There are a lot of researches already done in social media implementation in Banking Industry. However many results are still unknown. Our work is to explore the idea in the following points:

- Defining the attributes necessary for social media platform for Banking Industry in West Bengal.
- Discovering the best suitable social media site for Banking Industry in West Bengal.
- The graphical representation of adaptation of social media platform based on its attributes.
- Application of Triangular neutrosophic number based MCGDM problem for selection of social media platforms.

Discussion

This study was done primarily to understand the perceptions of the people of West Bengal to use social media for their banking transactions. The study examined the three different types of websites i.e. Face book, Twitter and You Tube individually using three different attributes: Safety & Privacy, Efficiency & Effectiveness and Fulfillment & Responsiveness.

The study yielded new viewpoints that are useful to both academicians and Banks. This study showed that the selection of social media for Banking depends on various attributes which differs based on customers' perception.

All the three social media considered in this paper is different in nature. Communications & Social groups like Face book, Messaging & Communication like Twitter, and Content & Communication like You tube. Publicity in these three different social media sites differ both in content and context. In the sample considered here men respondents are more than women; most of the respondents are under 40 years of age and they frequently uses social media. Like the worldwide trend here also it was observed that youngsters are dominating the social media sites. Social media mainly has impacted the life of youngsters. It has become radically significant since last ten years and it has attracted all age groups.

In West Bengal banking industry very less attention has been given to the measurement of social media quality and its effects. It is agreed that Banks must consider the overall social media quality measurement to satisfy customers. If the services experienced by customers are satisfactory, then it will induce them for long tern connectivity with banks. Long term connectivity with improved customer satisfaction in turn will bring customer loyalty.

Adaption of social media for banking industry is something beyond likes, comments and shares. The main aim of adaption of social media is brand awareness, creation of leads and ultimately conversions and finally brand advocacy. Banks should design their social media strategy considering their pragmatic goals. Once the goals are set it is important to find their KPIs (Key Performance Indicator) before implementing social media campaigns. A KPI is a quantifiable measurement to evaluate their campaign in relation to their defined goals. The common social media KPIs for banks can include Leads generation (through email signups or fulfilling some contact

forms), Conversions (account sign ups, deposits), Referral traffic (from social media to website), Brand Advocacy (Like, comment and share)
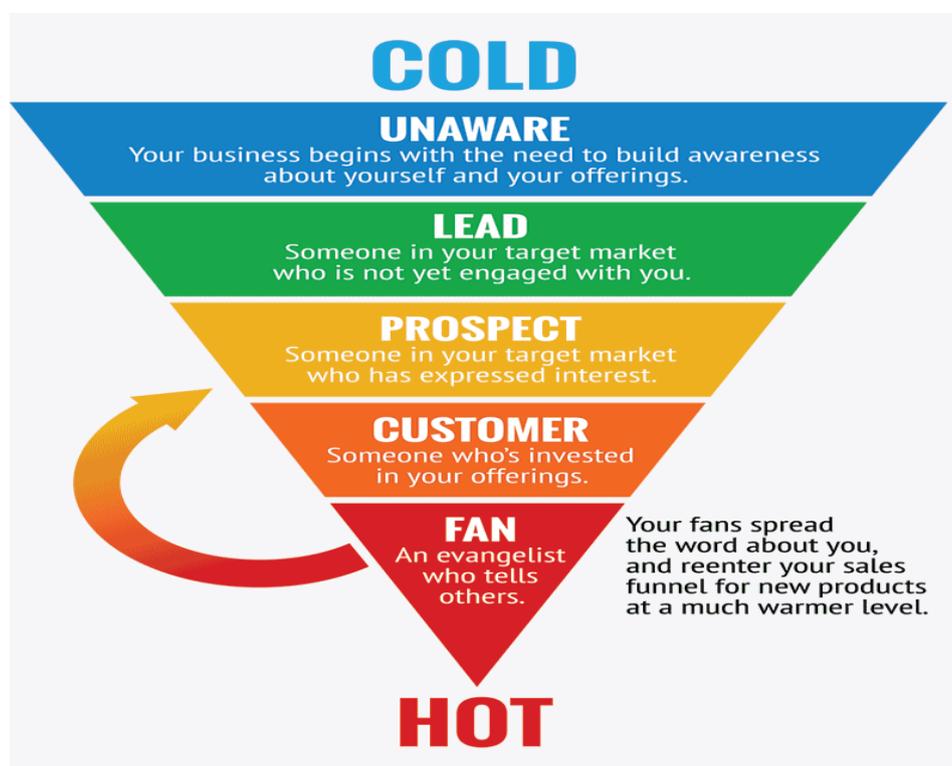

Figure 5.1: Example of Social Media KPI

6. Findings:

- All the three websites; Face book, Twitter and YouTube have gained attention among the social media users in India, but Face book is the widely used social media website.
- Banks are mostly using all international brands of social media channels for their operations due to lack of availability of good national social media networks. There is a great chance of development of some social media channels locally by the Govt.
- Bank's Social media Privacy drastically influences the endorsement of social media platform in the banking industry of West Bengal.
- Social media Efficiency appreciably control the acceptance of bank's social media platform in the West Bengal Banking Industry.
- Social media Fulfillment extensively influences the acceptance of social media platform in the West Bengal banking industry.

- Customers' prefer a bank that proposes them an experience that comprises all their service needs.
- All the three mentioned attributes have significant impact on overall customers' satisfaction which resulted in selection of Bank's social media platform
- Social media privacy appreciably persuades overall customer decision in selecting Banks social media sites in West Bengal banking industry. The study findings discovered that customers worth the social media privacy highly in banking operations.
- Face book is most preferred platform for all demography regardless of age, gender and occupation for all the Banks services.
- For You Tube and Twitter websites, people have different perceptions and choices depending on different Banks.
- Banks may augment their profit margin by increased customers' base through implementing proper social media strategies and reduction in cost due to lesser no of physical branches.

7. Conclusions:

In this current era, the West Bengal Banking Industry has conventionally been a high contact service submission. As implementation of social media reduces direct human interaction, hence there arises the need of continuous evaluation of service quality offered by Banks' social media sites and monitoring client's perception on it. It was observed that clients were satisfied with the traditional banking; still their expectations have grown bigger after introduction of e-services including social media.

This study concluded that the following attributes of social media like Safety & Privacy, efficiency & effectiveness and fulfillment & responsiveness have a significant influence on the service quality of social media in the West Bengal Banking Industry under neutrosophic environment. It was observed that customers mainly focuses on the attributes and service quality of Bank's social media, hence it is suggested that West Bengal Banking sector may priorities social media factors in their marketing mixes. Additionally, comparison analysis is done with the established methods and sensitivity analysis is performed in MCGDM technique under triangular neutrosophic arena. Finally it was concluded that successful implementation of social media in banking industry generates customer satisfaction and long term association which in turn converts to customer loyalty.

Further, researchers can apply this conception of triangular neutrosophic number in various fields like social business problem, diagnoses problem, mathematical modeling, pattern recognition problem, industrial problem, banking problem, marketing policy problem etc.

References:

[1] McNutt, K. (2014, March 13). Public engagement in the Web 2.0 era: Social collaborative technologies in a public sector context. *Wiley Online Library* .

[2] Constantinides E., F. S. (2008). Web 2.0: Conceptual foundations and marketing issues. *Journal of Direct, Data and Digital Marketing Practice* , 231-244.

[3] Alexandros Kapoulas, M. M. (2012). Understanding challenges of qualitative research: Rhetorical issues and reality traps. *QUALITATIVE MARKET RESEARCH, QMRIJ* .

[4] Cata, V. B. (2011). Marketing Opportunities with social networks. *Journal of Internet Social Networking and Virtual Communities* .

[5] Kaplan Andreas, H. M. (2009). Users of the world, Unite; The challenges and oppurtunies of social media. *Business Horizons* .

[6] Vadivelu Tharanikaran1, S. S. (2017). Service Quality and Customer Satisfaction in the Electronic Banking. *International Journal of Business and Management* .

[7] Cahyono, D. (2014). The influence of perceived service quality, attitudinal loyalty and corporate social responsibility on repeat patronage intention in retail banking in Indonesia. *Journal of Business and Retail Management Research* .

[8] Alexandros Kapoulas, M. M. (2012). Understanding challenges of qualitative research: Rhetorical issues and reality traps. *QUALITATIVE MARKET RESEARCH, QMRIJ* .

[9] Bausys, R., & Juodagalviene, B. (2017). Garage location selection for residential house by WASPAS-SVNS method. *Journal of civil engineering and management* , 421-429.

[10] Nisha Anupama Jayasuriya, S. M. (2017). The Impact of Social Media Marketing on Brand Equity: A Study of Fashion-Wear Retail in Sri Lanka. *International Review of Management and Marketing* .

[11] Kim, Y. (2016). Digital Media Use and Social Engagement: How Social Media and Smartphone Use Influence Social Activities of College Students. *Cyberpsychology, Behavior, and Social Networking* .

[12] Jalan, A. (2018). *Where will Man take us? The bold story of the man technology is creating.* Penguin.

[13] faisal shah, k. k. (2015). Impact of Service Quality on Customer Satisfaction of Banking Sector Employees: A Study of Lahore, Punjab. *Vidyabharati International Interdisciplinary Reserach Journal* .

[14] Louis Potgieter, R. N. (2017). Factors explaining user loyalty in a social media-based brand community. *SA Journal of Information Management* .

[15] Kumar, A. G. (2014). Impact of service quality dimensions in internet banking on customer satisfaction. *Decision* .

[16] Kim, Y. (2016). Digital Media Use and Social Engagement: How Social Media and Smartphone Use Influence Social Activities of College Students. *Cyberpsychology, Behavior, and Social Networking* .

[17] Cahyono, D. (2014). The influence of perceived service quality, attitudinal loyalty and corporate social responsibility on repeat patronage intention in retail banking in Indonesia. *Journal of Business and Retail Management Research* .

[18] K., G. B., L., V. K., & Liezel, C. (2019). The influence of social media service quality on client loyalty in the South African banking industry. *ACTA COMMERCII* .

[19] Ayesha L Bevan-Dye, U. A. (2015). South African Generation Y students' self-disclosure on Facebook. *South African Journal of Psychology* .

[20] Bramwell K. Gavaza, K. L. (2019). The influence of social media service quality on client loyalty in the South African banking industry. *ACTA COMMERCII* .

[21] Bevan-Dye, A. (2012). Relationship between self-esteem and Facebook usage amongst black Generation Y students. *African Journal for Physical Health Education* .

[22] Frederic Marimon, L. H. (2012). Impact of e-Quality and service recovery on loyalty: A study of e-banking in Spain. *Total Quality Management and Business Excellence* .

[23] Chung Tin Fah, M. A. (2012). Money Supply, Interest Rate, Liquidity and Share Prices: A Test of Their Linkage. *Global Finance Journal* .

[24] Rahimi, R., & Me, K. (2016). Impact of Customer Relationship Management on Customer Satisfaction: The Case of a Budget Hotel Chain. *Journal of Travel & Tourism Marketing* .

[25] Chinedu-Okeke, C. F., & Obi, I. (2016). Social Media As A Political Platform In Nigeria: A Focus On Electorates In South-Eastern Nigeria. *IOSR Journal of Humanities And Social Science* .

[26] Emel Kursunluoglu, I. (2015). A Review of Service and E-Service Quality Measurements: Previous Literature and Extension. *Journal of Economic and Social Studies* .

[27] Ajimon George, G. G. (2013). Antecedents of Customer Satisfaction in Internet Banking: Technology acceptance Model Redefined. *Global Business Review* .

[28] Norman Gwangwava, M. M. (2014). *E- Manufacturing and E-Servise Strategies in contemporary organizations.* Hershey-USA: IGI Global.

[29] L.A, Z. (1965). Fuzzy sets. *Information and Control* , 8(5):338- 353 .

[30] A.Chakraborty, S.P Mondal, A.Ahmadian, N.Senu, D.Dey, S.Alam, S.Salahshour; (2019); The Pentagonal Fuzzy Number: Its Different Representations, Properties, Ranking, Defuzzification and Application in Game Problem, Symmetry, Vol-11(2), 248; doi: 10.3390/sym11020248.

[31] A.Chakraborty, S. Maity, S.Jain, S.P Mondal, S.Alam; (2020); Hexagonal Fuzzy Number and its Distinctive Representation, Ranking, Defuzzification Technique and Application in Production Inventory Management Problem, Granular Computing, Springer, DOI: 10.1007/s41066-020-00212-8.

[32] S. Maity, A.Chakraborty, S.K De, S.P.Mondal, S.Alam; (2019); A comprehensive study of a backlogging EOQ model with nonlinear heptagonal dense fuzzy environment,Rairo Operations Research; DOI: 10.1051/ro/2018114.

[33] A.Chakraborty, S.P Mondal, A.Ahmadian, N.Senu,S.Alam and S.Salahshour; (2018); Different Forms of Triangular Neutrosophic Numbers, De-Neutrosophication Techniques, and their Applications, Symmetry, Vol-10, 327.

[34] A. Chakraborty, S. P Mondal, S.Alam, A. Mahata; (2019); Different Linear and Non-linear Form of Trapezoidal Neutrosophic Numbers, De-Neutrosophication Techniques and its Application in Time-Cost Optimization Technique, Sequencing Problem; Rairo Operations Research, doi: 10.1051/ro/2019090.

[35] A. Chakraborty, S. Broumi, P.K Singh;(2019); Some properties of Pentagonal Neutrosophic Numbers and its Applications in Transportation Problem Environment, Neutrosophic Sets and Systems, vol.28, pp.200-215.

[36] Garg, H. (2016). A novel accuracy function under interval-valued Pythagorean fuzzy environment for solving multicriteria decision making problem. *Journal of Intelligent & Fuzzy Systems* , 529–540.

[37] Wanga, X.-F., Jian-QiangWanga, & Yanga, W.-E. (2014). Multi-criteria group decision making method based on intuitionistic linguistic aggregation operators. *Journal of Intelligent & Fuzzy Systems* , 115-125.

[38] Wang, J., & Han, Z. Z. (2014). Multi-criteria Group Decision-Making Method Based on Intuitionistic Interval Fuzzy Information. *Group Decis Negot.* , 715-733.

[39] Chaio, K. (2016). The multi-criteria group decision making methodology using type 2fuzzy linguistic judgments. *Applied Soft Computing.*

[40] Wibowo, S., Grandhi, S., & Deng, H. (2016). Multicriteria Group Decision Making for Selecting Human Resources Management Information Systems Projects. *IEEE.Trans.*

[41] Seddikia, M., Anouchea, K., Bennadjib, A., & Boatengba, P. (2016). A multi-criteria group decision-making method for the thermal enovation of masonry buildings: The case of Algeria. . *Energy and Buildings* , 471–483.

[42] You, X., Chen, T., & Yang, Q. (2016). Approach to Multi-Criteria Group Decision-Making Problems Based on the Best-Worst-Method and ELECTRE Method . *Symmetry* , 1-16.

[43] Bausys, R., & Juodagalviene, B. (2017). Garage location selection for residential house by WASPAS-SVNS method. *Journal of civil engineering and management* , 421-429.

[44] J.Ye. (2009). Multicriteria fuzzy decision making method based on a novel accuracy function under interval-valued intuitionistic fuzzy environment, . *Expert systems with Applications* , 6809-6902.

[45] Chakraborty, A., Mondal, S. P., Alam, S., Ahmadian, A., Senu, N., De, D., et al. (2018). Disjunctive Representation of Triangular Bipolar Neutrosophic Numbers,De-Bipolarization Technique and Application in Multi-Criteria Decision-Making Problems. *Symmetry* , 932.

[46] Xiaohong, C., Yang, L., Wang, P., & Yue, W. (2013). A Fuzzy Multicriteria Group Decision-Making Method with New Entropy of Interval-Valued Intuitionistic Fuzzy Sets. *Journal of Applied Mathematics.* , 1-8.

[47] Büyüközkan, G., & Güleryüz, S. (2016). Multi Criteria Group Decision Making Approach for Smart Phone Selection Using Intuitionistic Fuzzy TOPSIS . *International Journal of Computational Intelligence Systems* , 9(4), 709-725.

[48] Chuu, S. J. (2007). Selecting the advanced manufacturing technology using fuzzy multiple attributes group decision making with multiple fuzzy information. *Computers & Industrial Engineering* , 57(3), 1033-1042.

[49] Liu, P., & Liu, X. (2017). Multi attribute Group Decision Making Methods Based on Linguistic Intuitionistic Fuzzy Power Bonferroni Mean Operators. *Complexity* , 1-15.

[50] M. Sahin, A. Kargın, F. Smarandache; (2018); Generalized Single Valued Triangular Neutrosophic Numbers and Aggregation Operators for Application to Multi-attribute Group Decision MakingNew Trends in Neutrosophic Theory and Applications. Volume-2.

[51] I. Deli, M. Ali, F. Smarandache, Bipolar Neutrosophic Sets and Their Application Based on Multi-Criteria Decision Making Problems; Doi- arXiv: 1504.02773.

[52] Smarandache, F. A unifying field in logics neutrosophy: neutrosophic probability, set and logic.American Research Press, Rehoboth. 1998.

[53] Abdel-Basset, M., Mohamed, R., Elhoseny, M., & Chang, V. (2020). Evaluation framework for smart disaster response systems in uncertainty environment. Mechanical Systems and Signal Processing, 145, 106941.

[54] A. Chakraborty, S. Mondal, S. Broumi; (2019); De-neutrosophication technique of pentagonal neutrosophic number and application in minimal spanning tree; Neutrosophic Sets and Systems; vol. 29, pp. 1-18, doi : 10.5281/zenodo.3514383.

[55] Abdel-Basset, M., Ali, M., & Atef, A. (2020). Uncertainty assessments of linear time-cost tradeoffs using neutrosophic set. Computers & Industrial Engineering, 141, 106286.

[56] A. Chakraborty, B. Banik, S.P Mondal, & S. Alam, (2020), Arithmetic and Geometric Operators of Pentagonal Neutrosophic Number and its Application in Mobile Communication Service Based MCGDM Problem, Neutrosophic Sets and Systems, 32, p.p-61-79.

[57] Abdel-Basset, M., Ali, M., & Atef, A. (2020). Resource levelling problem in construction projects under neutrosophic environment. The Journal of Supercomputing, 76(2), 964-988.

[58] A. Chakraborty, S. P Mondal, S. Alam, A. Mahata; (2020); Cylindrical Neutrosophic Single-Valued Numberand its Application in Networking problem, Multi Criterion Decision Making Problem and Graph Theory; CAAI Transactions on Intelligence Technology, Vol-5(2), pp:68-77, Doi: 10.1049/trit.2019.0083.

[59] Abdel-Basset, M., Gamal, A., Son, L. H., & Smarandache, F. (2020). A Bipolar Neutrosophic Multi Criteria Decision Making Framework for Professional Selection. Applied Sciences, 10(4), 1202.

[60] A. Chakraborty, (2020), Application of Pentagonal Neutrosophic Number in Shortest Path Problem. International Journal of Neutrosophic Science (IJNS), Vol-3(1), 21-28.

[61] Abdel-Basset, M., Mohamed, R., Zaied, A. E. N. H., Gamal, A., & Smarandache, F. (2020). Solving the supply chain problem using the best-worst method based on a novel Plithogenic model. In Optimization Theory Based on Neutrosophic and Plithogenic Sets (pp. 1-19). Academic Press.

[62] Mohamed, Mai, Mohamed Abdel-Baset, Florentin Smarandache, and Yongquan Zhou. A Critical Path Problem Using Triangular Neutrosophic Number. Infinite Study, 2017.

[63] Huang, Y. H., Wei, G. W., & Wei, C. (2017). VIKOR method for interval neutrosophic multiple attribute group decision-making. Information, 8(4), 144.

[64] Broumi S, Ye J, Smarandache F (2015) An extended TOPSIS method for multiple attribute decision making based on interval neutrosophic uncertain linguistic variables. Neutrosophic Sets Syst 8:22–31

[65] Brauers WKM, Zavadskas EK (2006) The MOORA method and its application to privatization in a transition economy. Control Cybern 35(2):445–469

[66] S. Pramanik, and K. Mondal; (2015); Interval neutrosophic multi-attribute decision-making based on grey relational analysis. Neutrosophic Sets and Systems, Vol-9, Pp-13-22.