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Customer Satisfaction in Mobile Service Using Fuzzy TOPSIS Method

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Abstract

Customer satisfaction in mobile service a mobile service provider cell phone for customer's data and phone wireless connectivity for calls a company that sells it is a mobile network operator, mobile carrier, cellular enterprise, or wireless may also be called service provider. Faster mobile services with growth and spread, customer satisfaction upgrading is key it has become a problem. Customer reviews customer satisfaction levels to monitor and improve as useful sources of information are recognized, esp. They are relatively obscure real from real customers expressing opinions. Expressing voices. Customer methodology of review analysis as a methodology, sentiment analysis has come forward. Multi-sensory analytical approaches customer sensational from the reviews although proposed to extract information, customer via mobile to monitor satisfaction customer reviews how to analyze effectively there is a drawback. Services. anytime, anywhere a seamless customer experience for everything you need to deliver a solution. An omni channel inbox to your customers by contact via preferred channel or you're via chatbot automate conversations. For frictionless service experiences mobile service cloud. fuzzy TOPSIS method, a more classical one of the MCDM methods as lee known and created, the basic concept of this method is, that is, the positive ideal a very short distance from the solution selected alternatives is also ideal far from negative will be. Mobile service for providers, customer reviews the mind of the customers useful for understanding and it will be a relatively low effort. Customers voluntarily earned by writing reviews knowledge is very reliable. Some kinds of mobile services' functional characteristics, advantages, and information such as cons customer reviews are spreading. However, the customer mobile service in monitoring the provider's efforts reviews have suffered due to the lack of an effective methodology for effective analysis Facebook, Google, Twitter, Skype, Word press. Message, Download, Search, Post. from the result, it is seen that google is got the first rank whereas is face book is having the lowest rank. Google holds the top spot, as does Facebook, which ranks low.

Keywords: Facebook, Google, Twitter, fuzzy TOPSIS.

1. Introduction

Mobile communication technologies and mobile services. Mobile business current internet sales channels are instant and personalized expanding to mobile environments. It is available to users from anywhere access the internet anytime capacity and personal mobile location of the terminal user marking skills are also required access to information in time also provides functionality. In this sense, mobile commerce customers and traditional unfulfilled e-commerce meet the needs of businesses with more flexibility to do and better services with efficiency it also has the potential to deliver. For customers and businesses to provide value-added services mobile services are huge provide opportunities [1]. Anywhere for information and services, universal and integrated access, and personal and personalized possibility of communication due to mobile services companies and increasingly consumers are gaining importance. These are the benefits however, customers' mobile devices are mainly voice services and text messaging they use them for simple services like for using mobile services driving forces of consumer intentions understanding them of consumers to use accomplishing objectives it is also important to adapt services accordingly. [2]. Current mobile services with location-aware features can be improved, thus the user eco-awareness services a smooth transition towards providing travel information, shopping, entertainment, event information, and like various mobile industries areas of possible use find the fields. This paper location-awareness from users reading mobile services. User interviews, lab and field evaluations with users, and location awareness expert evaluations of services based on the related to user requirements on key issues the essay concludes. [3]. Hence, mobile services identifying specific attributes a big challenge, is they are a wide range of mobile devices considering adoption is not yet popular in greece. However, possible solutions detection and their adoption a set of influencing factors making recommendations about an even bigger challenge. Currently individual uses mobile services in greek reality different affect the scope of users to the parameters finding the reaction is the purpose of the paper [4].significant of mobile services widespread expectations of experts have surpassed other telecommunications a "shadow" of providers from a

fringe industry fixed lines and internet, it has become a leading sector, commoditized services provides hence, mobile penetration of phones is individual twice as many computers it is too much. World in 2002 9.9% of the population had only computers, and 19% had cell phones [5]. Urban passenger transport increasingly in systems pressure to increase its effectiveness for new and innovative solutions increased demand. This is a challenge to overcome but the approach is slowly sustainable, shared mobility for services (car-sharing, bike-sharing, etc.) In particular with traditional public transport together, as an alternative to individually various transports to operate methods can be combined [6]. The purpose of engaging in a behavior and between actual behavior and theoretical for powerful communication and empirical support many studies have shown that to maintain the compactness of the instrument, behavioral intention and research actual use in model behavior for the connection of we accept the objective, more 3g mobile services of the individual to use we define purpose [7]. Variety of mobile services there are types. For example, mobile content and information services map, location-based services, news, personalization, and entertainment content downloads are mobile in different modes for users to make information available; short message service (sms), multimedia messaging service (mms), and email message services like text and exchange of multimedia messages enable; transaction based services are mobile banking, flight booking, etc executing transactions. Generally, mobile services ubiquitous and portable, personalized and contextual are characterized by awareness [8]. Mobile computing technology recent developments and of wireless networks by penetration, of services characteristic towards mobile services moves, the network-inhale from mobile devices made is becoming accessible. Popularity, variety, and complexity mobile-based services over the next few years will expand significantly expected. Complexity avoid escalation, users to focus on their tasks allow, mobile services about their contexts be aware and automatically adapt to changing environments environment to be modified awareness mobile services [9]. Mobile services generally and mostly implicitly mobile devices and or mobile using networks are understood as services. However, mobile and non-mobile networks draw a line between is difficult because wireless local area networks (wlans) cellular compared to networks provide less mobility. Also, mobile networks other than mobile phones are mostly used by devices, this includes laptop pcs or like a home alarm system there are fewer mobile devices [10]. For different application environments, different mobile services are offered. Learn to use them in situations where not much time is available more mobile services are provided. Like a sporting event in busy usage situations, a fast learning process is essential. After some time of use, the system is considered a positive desired service it is also important for the provider. In this sense, short-term mobile users of the services studying and long-term comparison with users is essential [11]. Mobile services, communication, information, transaction, and entertainment as services are highly efficient and delivered through networks, the internet on mobile devices with the look and feel to use multimedia services enables, for example, mms, mobile video, mobile internet, mobile games, mobile banking and mobile commerce. We select specific services the reasons for doing so are different kinds of services that attract value we want to have a mix. Travel service, m-commerce, or news services in nature same as considered very specific while, mobile services, mobile data or internet services are interchangeable and are used as general concepts [12]. Mobile ticketing also, according to our model, utility is, the intended use of utility and motion upon the effect is fully mediated does, of mobile services advantages they will be used that depends on the circumstances recommends. Other is adoption conclusions from the results of the studies differentiated and common adoption principles are mobile and situational and must be augmented with factors pointed out [13]. One of the telecom markets decreased average revenue per user to respond to incoming, mobile data services mobile services underline the importance show new mobile this acceptance of the services rejects the proposition because it's much slower than expected there is, especially in europe. However, basic services grew rapidly [14]. Mobile commerce mobile services, mobile technologies and includes business models. Evolution of mobile technologies, development, and innovation with the emergence of business models, mobile in people's daily lives we see growth in services. Wireless in a wireless environment various through the network through mobile devices better service to their users provide mobile services offering a completely new way [15]. In many countries around the world, new m-services at a rapid pace are started. However, in most western countries, wireless application protocol or experience with wap significant technological advances and service availability is automatic their widespread adoption and does not lead to the use of mobile content organizations involved in delivery are aware. [16]. In mobile technology applications, mobile services for research are a major challenge. Early mobile commerce advertisement "killer apps" based on searching, ie mobile services domain launcher, mobile technology quick and easy of applications ensure profitable growth. Finnish for mobile services two of the consumer market comparing the results of studies by, the use of mobile services how consumers take we have examined that [17]

2. Materials & Methods

Alternative: facebook, google, twitter, skype, wordpress.

Facebook: meta platforms, inc., business as meta, ago facebook, inc. And the facebook, inc. Named, this menlo, california a located in the park american multinational technology is a company. Company facebook, Instagram and whatsapp other products like and owns the services.

Google: google llc is a search engine technology, online advertising, cloud computing, computer software, quantum computing, e-commerce, artificial intelligence, and consumer electronics will focus on an american multinational technology company.

Twitter: twitter, inc. Is california one in san francisco an american social media company. Company microblogging and social networking service turn on twitter. This is a previously vine short video app and periscope enabled live streaming service.

Skype: skype is a microsoft by a division of skype technologies a proprietary operated telecommunication application, it is voip-based video telephone, video conferencing and so for voice calls popular. It's instant messaging, file transfer, landline, and for mobile phones debit based calls and has other features as well.

Wordpress: wordpress is a free and open-source content management system. A plugin in features framework and a template organization includes, this is "themes" in wordpress.

Evaluation preference: message, download, search, post.

Message: a message is some recipients or group of recipients aimed at the source of consumption a separate communication unit is a courier, telegraph, carrier pigeon, and electronic bus a variety of ways let's deliver the message.

Download: in computer networks, download it from a remote system getting data, usually web server, ftp server, email server, or server like any other similar system.

Search: by inquiry or inspection to discover, to discover, or to know. Usually used without. Intransitive verb: carefully to see or inquire.

Post: monitor status 166 or send an sms to 51969 alternatively, you govt check out the website cargo at www.indiapost.gov.in find out the status. India go to the post and your requirement to choose a suitable fit get more helpful information.

Fuzzy TOPSIS Methods: An important one in gran canaria of three hotels of the corporation service quality changes fuzzy TOPSIS for evaluation land by approach studies. The fuzzy TOPSIS method is alpha based on levels and a non-linear programming solution provides a process. Supply chain supplier selection problem in the system fuzzy topsy approach to with deal [18]. TOPSIS is widely used as a decision-making technique, fuzzy TOPSIS or group fuzzy for a reliable version of TOPSIS more intensive to achieve this goal research, comparisons, and benchmarking still need that process we believe. Finally, the z-number or ambiguous mixed number in an essay is used. Such limited efforts to extend the TOPSIS are kind of vague and useful. Readers or not does not allow you to make a firm decision [19]. Fuzzy TOPSIS methods are sufficient are capable because a fuzzy positive-best solution and a fuzzy negative-best solution to get the ambiguous fuzzy ranking approaches are used. Ella in cases and circumstances satisfying numbers. The best solution and from the negative-best solution calculating distance is difficult. In fuzzy decision-making to solve these problems, a new ambiguity a TOPSIS approach is proposed [20]. Fuzzy TOPSIS method. Through unity for a better solution (TOPSIS). Technique for order prioritization hwang et started by yoon. This technique is the best alternative excellent for all properties considered to have the position, whereas negative is better for all bad attribute values based on the idea that to solve the limitations, robot selection the TOPSIS method is ambiguous for the problem recommended, there are different criteria and different subjectivity ratings are below by triangular fuzzy numbers of the various alternatives mentioned evaluated on the linguistic basis [21]. To solve these problems, plant location a fuzzy for selection problems a TOPSIS approach is recommended. A better solution for order priority by the similarity technique initiated by Hwang and Yoon, this technique is the best alternative for all attributes the idea that there is a better position based on, whereas excellent for all attributes the idea that there is an alternative better position based on, whereas a negative ideal is all bad. Attribute values. A topsy solution is the only one from the negative ideal far away in time and the closest substitute to the best substitute is defined. In fuzzy TOPSIS, attribute values are represented by fuzzy numbers [22]. For an ideal solution in fuzzy environments (TOPSIS) a technique for similarity order preference, Fuzzy TOPSIS, has in many practical, real-world challenges used successfully. This paper is about fuzzy TOPSIS applications and provides a brief review. Of the 25 studies conducted in the years 2009 - 2018 this research has been carried out. Most related to fuzzy TOPSIS technique relevant and highly cited provides a brief review. Applications such as resources, business, healthcare, etc classified into parts. Fuzzy TOPSIS implementations, fuzzy sets, non-hesitant fuzzy sets, or intuition fuzzy, like a fuzzy set by other methods combined with TOPSIS, the approaches used are examined and compared [23]. TOPSYS uses traditional one of the multi-criteria decision-making methods of Hwang and Yoon (1981). Created by choosing from an alternative positive ideal solution (PIS) a very short distance is negative away from the best solution (NIS). It is based on the idea of having to be located. TOPSIS is easy to understand and programmable computing also provides processes. With different units simultaneously taken into account, various criteria can absorb. Many obscure TOPSIS in recent years have been created. First, installing obscure TOPSYS that used ambiguous numbers can absorb [24]. Among many popular MCDM methods, by corresponding to the best solution technique for order performance (TOPSIS) stands for euclidean distances many possible by measuring and ranking the alternatives to select the technique practical and useful the way TOPSIS was originally developed by Hwang and Yoon (1981) created by. Created by choosing from an alternative positive ideal solution (pis) the concept of having a very short distance based on and negative ideal solution (NIS) is

far from a distance, cost criterion solution, and benefit criteria increases and decreases [25]. Additionally, by different distance measurement values of the given interval ambiguous, TOPSIS results a comprehensive examination of observations analysis is presented. Distance from each distance measure comparison of valued fuzzy TOPSIS rankings analysis, stability ratios, odds ratios and mean spearman with discussions of correlation coefficients explained. In solving a plant design problem. The difference between is mainly evaluation is in approaches. Accurate fuzzy numbers instead of numbers by using vary depending on the attributes, of the importance and effectiveness of the attributes of alternatives the merit of fuzzy TOPSIS are to provide [26]. To solve mara's WD problem a fuzzy MCDM called fuzzy topics we have used the method. Some fuzzy MCDM methods and fuzzy a brief overview of TOPSIS and applications are also provided in this section. All evaluations in fuzzy TOPSIS weights are also by linguistic variables are defined. Triantafillo and lin (1996) are an ambiguous TOPSIS-developed system, in which each relative proximity to replacement is ambiguously evaluated based on arithmetic operations. Liang (1999) for the ideal and ideal based on opposing views proposed fuzzy MCDM. Chen's (2000) triangulation treated fuzzy numbers and the TOPSIS method for fuzzy GDM situations between two fuzzy numbers to extend defined smooth euclidean distance [27]. Linguistic preferences, in fuzzy TOPSIS easily as fuzzy numbers can be converted and used in calculations. Simple and fast calculations and tolerance of uncertainty are some great features like handling by having, energy planning many ambiguous problems to solve TOPSIS applications have been used [28]. The fuzzy topics method alpha condition sets and fuzzy extensions are based on principle, which models non-linear programming of each alternative by solving and also calculates fuzzy relative proximity. Decomposing fuzzy relative closeness values the final ranking is obtained by in this paper, interval to solve MCDM problems value fuzzy TOPSIS (IVF-TOPSIS) we develop, performance appraisal in this of values and criteria weights are linguistic terms, which space-valued ambiguity (IVFN) can be expressed in numbers [29]. Then fuzzy TOPSIS method was introduced. Structure and the strength of both methods' efficiency in the dairy sector are the real of a company that works tested by application to the case. Fuzzy logic and TOPSIS method quantitative details are described in the appendix [30]. This research is fuzzy TOPSIS weight of each criterion acceptance as a deterministic analytical tool. Ambiguity theory uncertainty and perfect for dealing with complex situations provide the tool. MCDM problems solving fuzzy sets fuzzy TOPSIS method is the purpose of this article use according to our research results, shopping to improve the competitive advantage of the website the most important factors are security and trust [31].

3. Result and Discussion

TABLE 1. Mobile Service

	DATA SET			
	Message	Download	Search	Post
Facebook	0.59	0.66	0.18	0.44
Google	0.92	0.86	0.12	0.18
Twitter	0.71	0.71	0.14	0.24
Skype	0.61	0.77	0.18	0.38
WordPress	0.80	0.95	0.17	0.17

Table 1 shows the Mobile Services of the Alternative: Facebook, Google, Twitter, Skype, and WordPress. Evaluation Preference: Message, Download, Search, Post.

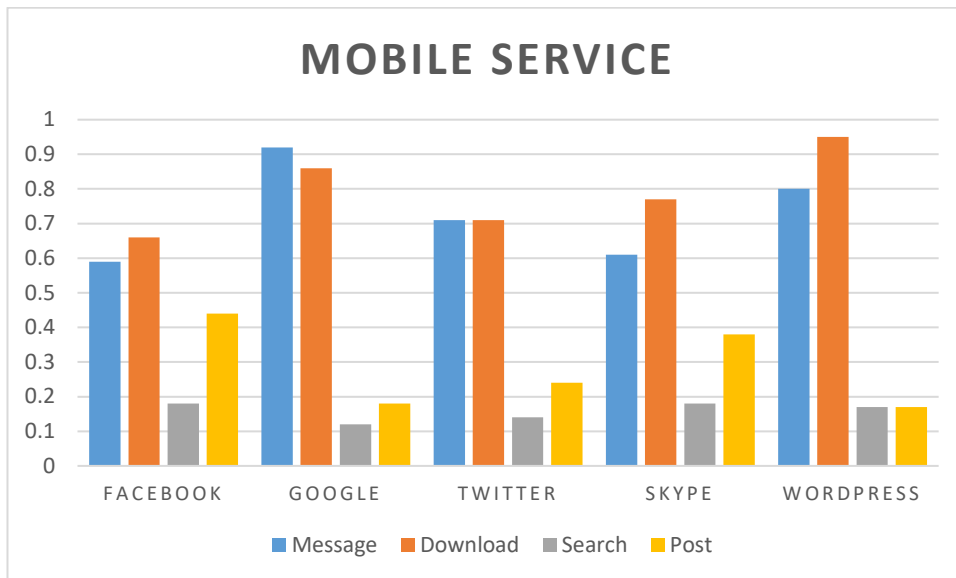


FIGURE 1. Mobile Service

Figure 1 shows the graphical representation of the Message it is seen that Google is showing the highest value for Facebook shows the lowest value. Download it is seen that Wordpress is showing the highest value for Facebook is showing the lowest value. Search it is seen that Facebook is showing the highest value and Google is showing the lowest value. Post it is seen that Facebook is showing the highest value for Wordpress is showing the lowest value.

TABLE 2. Squire Rote of matrix

0.3446	0.4382	0.0331	0.1910
0.8446	0.7344	0.0149	0.0331
0.5041	0.4970	0.0204	0.0590
0.3770	0.5883	0.0331	0.1459
0.6384	0.9025	0.0292	0.0292

Table 2 shows the Squire Rote of matrix value.

TABLE 3. Fuzzy Significance

		1	m	u
Extremely low	EL	0	0	0.1
very low	VL	0	0.1	0.3
low	L	0.1	0.3	0.5
medium	M	0.3	0.5	0.7
high	H	0.5	0.7	0.9
very high	VH	0.7	0.9	1
Extremely high	EH	0.9	1	1

Table 3 shows the Fuzzy Significance Collect the subjective evaluations of the decision maker on the importance of weights. Calculate the fuzzy significance coefficients or weights based on the decision maker’s subjective evaluations by using the following table and equations.

TABLE 4. The criteria’s on a linguistic scale

	DM1	DM2	DM3
Message	EH	VL	M
Download	L	EH	VH
Search	L	M	VH
Post	L	M	VL

Table 4 shows the criteria’s on a linguistic scale.

TABLE 5. Convert linguistic ratings of decision makers into quantities values by using the selected fuzzy number

	DM1			DM2			DM3		
Message	0.9	1	1	0	0.1	0.3	0.3	0.5	0.7
Download	0.1	0.3	0.5	0.9	1	1	0.7	0.9	1
Search	0.1	0.3	0.5	0.3	0.5	0.7	0.7	0.9	1
Post	0.1	0.3	0.5	0.3	0.5	0.7	0	0.1	0.3

Table 5 shows the Convert linguistic ratings of decision makers into quantative values by using the selected fuzzy number.

TABLE 6. Calculate aggregated Fuzzy weights

	L-FW	M-FW	U-FW
Message	0.4	0.533333	0.666667
Download	0.566667	0.733333	0.833333
Search	0.366667	0.566667	0.733333
Post	0.133333	0.3	0.5

Table 6 shows the Calculate aggregated Fuzzy Weights Message, Download, Search, Post.

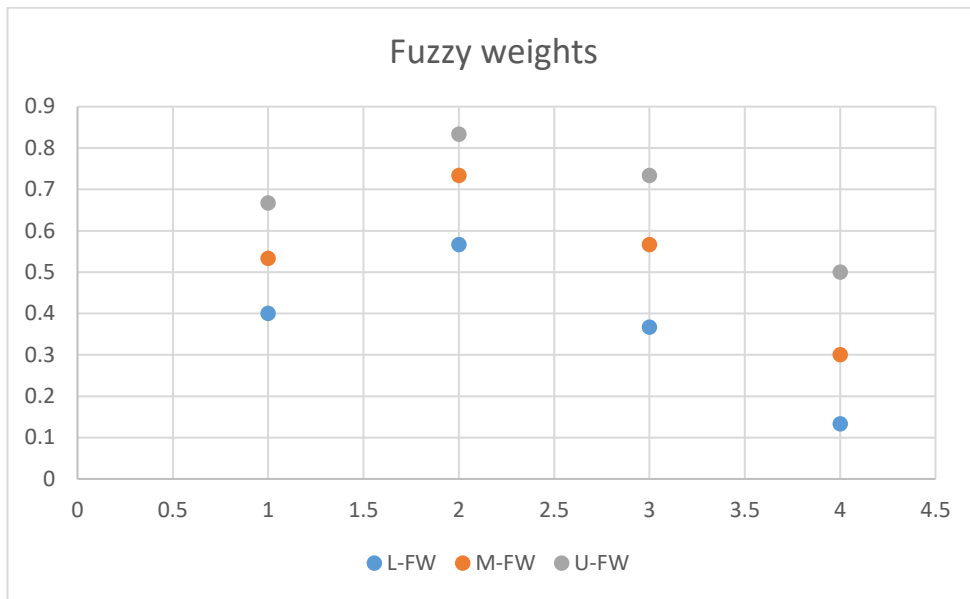


FIGURE 2. Fuzzy weights

Figure 2 shows the graphical representation the aggregated Fuzzy Weights Message, Download, Search, Post.

TABLE 7. Normalized Data

Normalized Data			
Message	Download	Search	Post
0.3567	0.4022	0.5032	0.6455
0.5584	0.5207	0.3373	0.2688
0.4314	0.4284	0.3954	0.3589
0.3731	0.4660	0.5032	0.5643
0.4855	0.5772	0.4728	0.2526

Table 7 Normalized Data shows the Alternative: Facebook, Google, Twitter, Skype, and WordPress. Evaluation Preference: Message, Download, Search, Post. The Normalized data is calculated from the data set value divided by the sum of the square root of the column value.

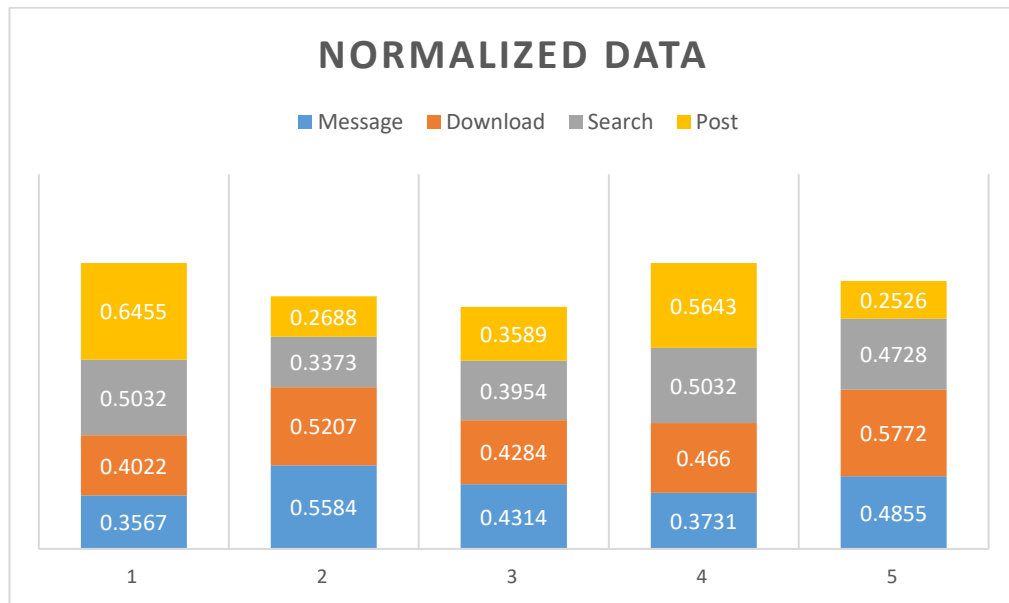


FIGURE 3. Normalized Data

Figure 3 shows the Message it is seen that Google is showing the highest value for Facebook is showing the lowest value. Download it is seen that WordPress is showing the highest value for Facebook is showing the lowest value.

TABLE 8. Weighted normalized decision matrix

Weighted normalized decision matrix											
Message			Download			Search			Post		
0.142667	0.190223	0.237778	0.227935	0.294975	0.335199	0.184503	0.28514	0.369005	0.086068	0.193653	0.322755
0.223358	0.29781	0.372263	0.295076	0.381863	0.433935	0.123678	0.191138	0.247355	0.035845	0.080652	0.13442
0.172561	0.230082	0.287602	0.24274	0.314135	0.356971	0.144966	0.224039	0.289933	0.047859	0.107684	0.179473
0.149229	0.198972	0.248715	0.264088	0.341761	0.388364	0.184503	0.28514	0.369005	0.075236	0.16928	0.282134
0.194192	0.258923	0.323654	0.327097	0.423302	0.481025	0.173351	0.267907	0.346703	0.033679	0.075777	0.126295

Table 8 Shows the Weighted normalized decision matrix Fuzzy weighted decision matrix by multiplying the normalized matrix with corresponding fuzzy weight.

TABLE 9. A+ & A-

A+	0.2233 58	0.2978 1	0.3722 63	0.3270 97	0.4233 02	0.4810 25	0.1236 78	0.1911 38	0.2473 55	0.0336 79	0.0757 77	0.1262 95
A-	0.1426 67	0.1902 23	0.2377 78	0.2279 35	0.2949 75	0.3351 99	0.1845 03	0.2851 4	0.3690 05	0.0860 68	0.1936 53	0.3227 55

Table 9 Shows the A+ Maximum, minimum value & A- Minimum, Maximum value.

TABLE 10. FPIS

FPIS	Facebook	0.109806132	0.125918514	0.095454792	0.135690501
	Google	0	0.040661187	0	0.005611261
	Twitter	0.069124945	0.10711818	0.033409177	0.036728256
	Skype	0.100876115	0.080010722	0.095454792	0.107634194
	WordPress	0.039688963	0	0.077954747	0

Table 10. Shows the The coordinates for the fuzzy positive ideal solution (FPIS).

TABLE 11. FNIS

FNIS	Facebook	0	0	0	0
	Google	0.109806	0.085257	0.095455	0.130079
	Twitter	0.040681	0.0188	0.062046	0.098962
	Skype	0.00893	0.045908	0	0.028056
	WordPress	0.070117	0.125919	0.0175	0.135691

Table 11. Shows the coordinates for the fuzzy Negative ideal solution (FNIS).

TABLE 12. Si+ & Si-

Si+	Si-
0.46687	0
0.046272	0.420597
0.246381	0.220489

0.383976	0.082894
0.117644	0.349226

Table 12. Shows the Euclidean distance of each alternative from positive and negative value calculated as. Where represents the distance between two fuzzy numbers calculated by S+, S- value.

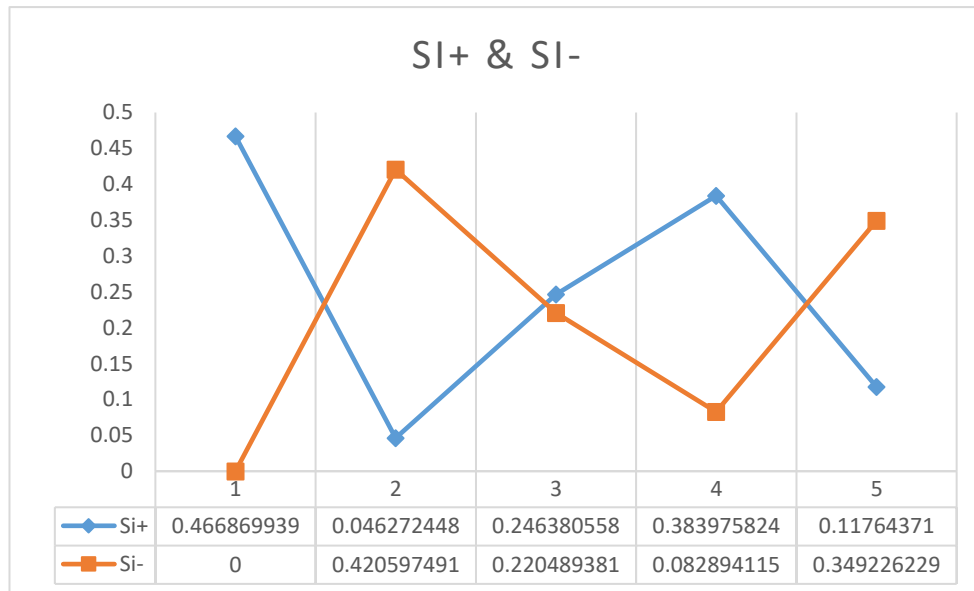


FIGURE 4. S+&S-

Figure 4 shows the graphical representation S+, S- value.

TABLE 13. Rank

	Cci	Rank
Facebook	0	5
Google	0.900888	1
Twitter	0.472272	3
Skype	0.177553	4
WordPress	0.748016	2

Table 13 shows the closeness coefficient C_{ci} of the alternatives are calculated using equation ranked as per descending order. the final result of this paper is the Facebook is in 5th rank, Google is in 1st rank, Twitter is in 3rd rank, Skype is in 4th rank and the WordPress is in 2nd rank. The final result is done by using the Fuzzy TOPSIS method.

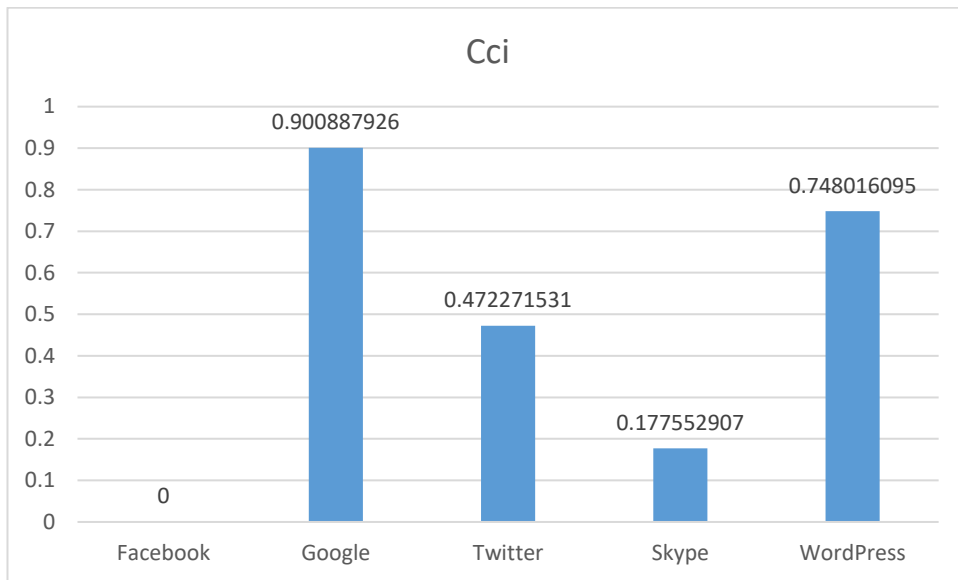


TABLE 5. closeness coefficient CCI

Figure 5 shows the graphical representation view Facebook 0, Google 0.900888, Twitter 0.472272, Skype 0.177553, WordPress 0.74801.

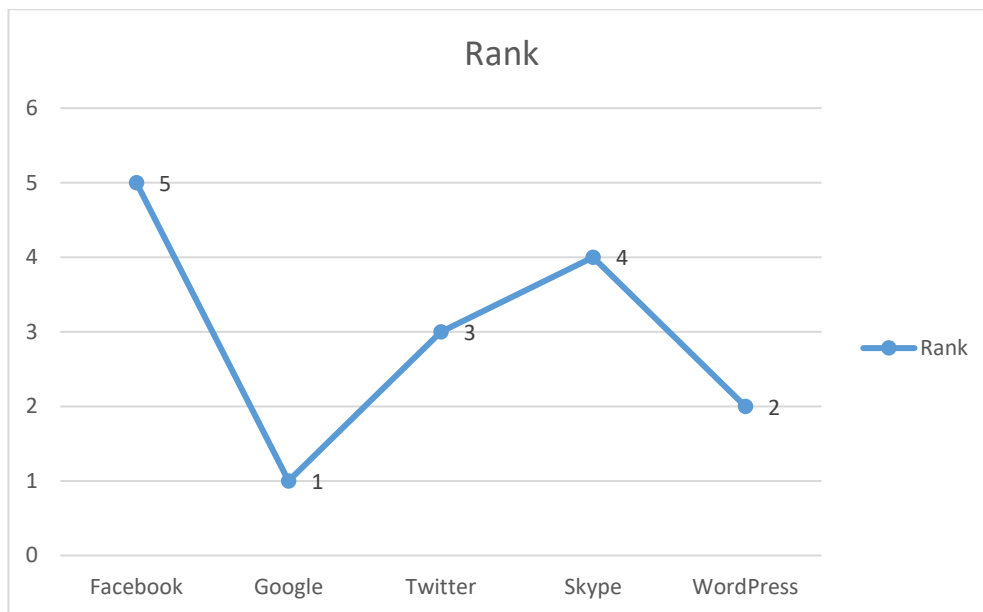


FIGURE 6. Rank

Figure 6 shows the graphical representation view the final result of this paper Facebook is in Fifth rank, Google is in First rank, Twitter is in the third rank, Skype is in fourth rank and the WordPress is in Second rank

4. Conclusion

In any business enterprise, Customer satisfaction is an important success mantra that has been identified. Customer satisfaction is in exchange for experienced service Appropriateness of reward received or of disqualification Cognitive level of consumers. Customer satisfaction is Usually post-consumer and Defined as a value judgment. Customer satisfaction is a product or service of fulfillment related to consumption that Provides a satisfactory dose. In addition, remarkable production or a variety of service Attribute related satisfaction As a summation of judgments Being evaluated, contentment is Referred to as synonymous with attitude. Customer satisfaction is single or multiple indicator pointed out that can be measured. Including telecommunication services are diverse Since every service Customer satisfaction in components is necessary to detect and measure. A study of customer satisfaction Focuses on the characteristics of satisfaction It Pays and is very accurate and provides reliable information Because satisfaction with a service attributes Dissatisfaction with this service overall leads to satisfaction/dissatisfaction. Mobile Telecom The industry is complex today and a thriving dynamic environment Service is one of the businesses. of information in daily activities Importantly, this industry too Expands immediately. This By instant change, mobile Service providers to customers New and advanced features Improved technology Can be provided at a reasonable price. Like any other business domain, MSPs care about their customers too Considered an important asset. Constantly increasing Customer needs, market In industry by share To maintain stability Since the key is Customers' preference and Focus on the concept of satisfaction Payable potential improvements forcing companies to seek Customer reviews are frequently used to monitor, So, in mobile services Improves customer satisfaction. What is a customer review? A for average ratings An attractive alternative, at that The latter, in their generality Given a binomial distribution, Mostly customer satisfaction Particularly useful information on does not provide In binomial distributions, Average ratings are very high or be very low, And customer satisfaction To monitor and improve Lots of helpful information May not report. Real Customer reviews, on the other hand, Voices of customers Includes, it's given Positive and negative of the service Reveal features vividly. So, real customer Reviews, on mobile services Valuable information for monitoring and improving customer satisfaction are recognized as evidence. The final result of this paper is Facebook At the fifth rank, Google at is first Rank and Twitter third rank, Skype in the fourth place, and WordPress also ranks second.

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