Sweta Singh *et al*, International Journal of Computer Science and Mobile Applications,
Vol.6 Issue. 4, April- 2018, pg. 150-162 **ISSN: 2321-8363**
UGC Approved Journal
Impact Factor: 5.515

Recommender System for Mobile Phone Selection

Sweta Singh[1], Prasant Kumar Pattnaik[2]
[1]Kalinga Institute of Industrial Technology, 1415043@kiit.ac.in
[2]Kalinga Institute of Industrial Technology, patnaikprasantfcs@kiit.ac.in

Abstract: ***This paper evaluates the usability value of the mobile phones based on user choice using AHP method of multi-criteria decision-making technique. The usability value enables the system to rank the attributes according to user requirements that help them to select the best one. we have considered three types of mobile sets Apple, Samsung and Vivo. In order to rank the attributes, we use the usability value. AHP method helps in the calculation of usability value. AHP uses hierarchical approach for setting the criteria and performance evaluation process for the rating and ranking of items for the optimal suggestion to the user according to the user demand and preferences.***
Keywords: Mobile phones, Recommender system, AHP, TOPSIS, Usability value.

1. Introduction

Recommender Systems is widely adopted as information search technique that provides a suggestion for items which are relevant to a user as per their requirement. Generally, the user experience is considered and the system is able to provide suggestion to the active user who is seeking suggestion using MCDM techniques [1]. Many commercial online applications seeking recommender system in order to provide the support to users with the better choice of items say an example music selection, news selection, car selection and also help in other financial investment. However, Recommender system is used in mobile phone selection due to the availability of varieties of features, design, functions, and brands that create lots of confusion for the user to select the best one according to their requirement and preferences.

1.1 Mobile phone selling and purchasing trend

With recent advancement in technology, a mobile phone can do all the jobs a computer is capable of and also more than half of the internet traffic is coming from mobile devices, which is a clear indication that their demand and usage are increasing at an enormous pace. Earlier the number of mobile phone user in a family was limited to a couple of persons but nowadays almost each and every member of the family have a mobile device due to which demand is increasing and mobile phone companies are also improving the functionalities and design to attract more and more users [15].

1.2 Need of recommender system for mobile phone

Mobile phones have become an essential requirement in our day to day life. According to a research, it is expected that the number of mobile phone users across the world will exceed billions by 2019. Due to this huge increase in their demands, their variants are also increasing at an exponential rate, which creates a lot of confusion for the buyers and they may end up buying an inappropriate product. To overcome these problems of information overload, a Recommender System provides suggestion to the user based on their requirements and also (considering/taking into account) their previous preferences [16].

1.3 Challenges with mobile phone selection

Due to rapid growth in the varieties of mobile phone based on their design and functionalities, it is becoming very difficult for the user to select the best mobile phone according to their requirements and preferences. The main problem in mobile phone selection is the comparison between the different items, which is very complex and manually it cannot be done [16]. Therefore a systematic approach is required for the complex comparison between the items and to suggest the user most appropriate item according to their preferences. Recommender system helps in doing a comparison and evaluation over large varieties of mobile phone functionalities, features, design, and brand to provide an efficient suggestion for the item.

2. Some Commercially available mobile phones

The popularity of commercial phones came into existence after the portable telephones started its creation. Many phones were launched, which provide the facilities for internet access and other multimedia services including normal services of voice calling and text messages that are known as a feature phone[2][3]. Feature phones are evolved into smartphones, which are equipped with advanced technologies and features like fast internet access, high-speed processor, efficient battery back-up, large storage service, multitasking etc. Some of the mobile phone brands namely Samsung, Apple, Nokia, Sony, Oppo, Vivo, Blackberry, and HTC. They are able to cater the needs of demand. Some of them discussed below.

2.1 Samsung

Samsung is an electronics multinational company of South Korea. It is a big competitor to other big companies like Apple, Nokia. In 2012, Samsung had become the world largest mobile phone producer. It reached the selling of 95 million smartphones in the starting few months of 2012 [4]. By the end of 2013, Samsung smartphones had increased its sale in other countries like India [5].

2.2 Apple

Apple is a technology-based multinational company in America. Its smartphones are named as iPhones, which runs on Mac operating system. In 2012, Apple introduced iPhone 5S and iPhone 5C, which is an upgraded version of previous iPhone set. It set a record by selling millions of iPhone 5S and iPhone 5C in starting first three days from its launch date [6]. Apple is working towards many advanced features such as power management system and detection function. Power management system calculates the amount of time in which user will not be consuming any power so that the device will modify the power usage. The detection system detects the power source that is used for the charging and adjusts the charging rate accordingly [7].

2.3 Vivo

Vivo is Chinese based manufacturer company for the handheld mobile devices. In the starting of 2015, Vivo has ranked among top 10 smartphone makers [9]. In 2018, Vivo has introduced world's very first mobile phone

that has finger touch scanner on the screen of the mobile device. In 2017, Vivo made a sponsorship deal with FIFA so that it will become an official smartphone brand [8].

3. Recommender system using MCDM techniques

Recommender system includes multiple criteria for the selection of the item, therefore, it can be treated as multiple criteria decision-making (MCDM) technique. There are many MCDM methods, which are used in the appropriate item suggestion approach. Some of them are discussed below.

- Analytic hierarchy process (AHP) [11]
- The technique for an order of preference by similarity to ideal solution (TOPSIS) [10]

3.1 AHP

AHP is one of the multiple criteria decision-making(MCDM) method which uses hierarchical approach for setting the criteria and performance evaluation process for the rating and ranking of items for the optimal suggestion to the user according to the user demand and preferences. It is used to determine which criteria in the design are most important and then by using that information, it helps in the selection, which design is the best.

As it is based on decision theory, it is very much effective in many different cases of buying cars, buying houses and even choosing many other multi-criteria based objects. It reduces user efforts and time in searching and selecting the item according to their requirements and it provides the most appropriate suggestion based on the user's preferences.

AHP includes the following steps in the evaluation process of ranking the attributes.

STEP 1: Designing of hierarchical design of criteria and the alternatives.

STEP 2: Designing of the rating scale.

STEP 3: Designing of criteria pairwise comparison matrix using a rating scale.

STEP 4: Designing of normalization matrix for comparison matrix.

STEP 5: Designing of the weight matrix for the criteria.

STEP 6: Calculation of usability value by doing the product of satisfaction degree matrix and the

weight matrix.

STEP 7: Compare different alternatives using usability value for the criteria.

 ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

3.2 TOPSIS

TOPSIS is the method in MCDM, its goal is based on the concept of selecting an alternative that has a minimum distance from the positive ideal solution(PIS) and maximum distance from the negative ideal solution(NIS). It is the method of finding an item which is closest to an ideal solution so that the benefit is maximized.

It gives the ranking to the alternatives as the ideal solution rank 1 whereas the worst solution rank nearly to 0. It also reduces the complex comparison between the alternatives and user's time in the selection of appropriate item/alternative.

TOPSIS includes the following steps in the evaluation process of ranking the attributes.

STEP 1: Select the criteria for the alternatives.

STEP 2: Design the decision matrix for the selected criteria.

STEP 3: Design the normalization matrix for decision matrix.

STEP 4: Design the weight matrix for the criteria using AHP method.

STEP 5: Identify and create PIS and NIS using weight matrix.

STEP 6: Evaluate all possible alternatives distance(separation) from PIS and NIS.

STEP 7: Calculation of relative nearness distance of each alternative with respect to the ideal solution.

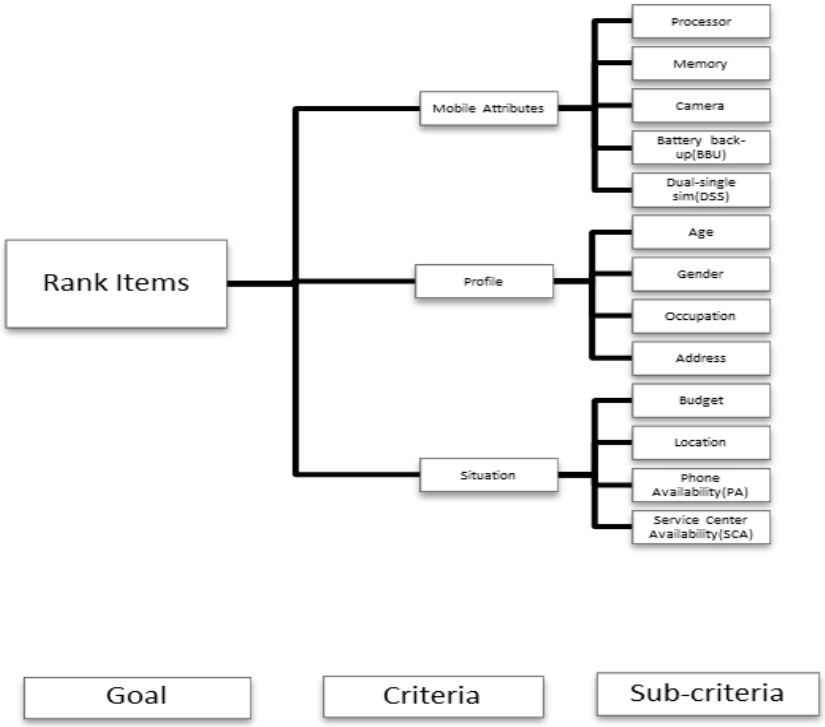
STEP 8: Compare and position different alternatives.

4. Recommender system for mobile phones using AHP technique

In this experiment, we have considered three types of mobile sets Apple, Samsung and Vivo. In order to rank the attributes, it is divided into three criteria that are Profile, Situation, and Mobile Attributes. Again each criterion is further divided into sub-criteria as follow Profile(age, gender, occupation, address), Situation(budget, location, phone availability, service center availability), Mobile Attributes(processor, memory, camera, dual-single sim). The configuration is given in fig. 1. This has been conducted with the help of a questionnaire and AHP technique [12][13][14].

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

Fig.1 Construction of criteria hierarchy for alternatives.



4.1 Rating scale design

Rating scale consists of five points. Each point compares the two criteria P and Q, then according to the priority level of criteria P over criteria Q, it gives the value from 1 to 9 on the rating scale table. If criteria P and criteria Q have an equal case then the value is 1. If criteria P and criteria Q have a moderate case then the value is 3. If criteria P and criteria Q have a strong case then the value is 5. If criteria P and criteria Q has a very strong case then the value is 7 and if criteria P and criteria Q have an extreme case then the value is 1.

Table 1 Rating scale table

Variable name	Symbol	Value
Equal case	EQC	1
Moderate case	MC	3
Strong case	SC	5

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

Very strong case	VSC	7
Extreme case	EC	9

4.2 Construction of comparison matrix for criteria using above rating scale

The comparison matrix for criteria Profile, Situation, and Mobile Attributes are given in table 2, 3, 4 respectively.

Table 2 Comparison matrix for profile

	Address	**Occupation**	**Gender**	**Age**
Address	1	1/3	1/5	1/9
Occupation	3	1	1/3	1/7
Gender	5	3	1	1/5
Age	9	7	5	1

Table 3 Comparison matrix for the situation

	SCA	**PA**	**Location**	**Budget**
SCA	1	1/3	1/5	1/9
PA	3	1	1/3	1/7
Location	5	3	1	1/5
Budget	9	7	5	1

Table 4 Comparison matrix for mobile attributes

	Processor	**Memory**	**Camera**	**DSS**	**BBU**
Processor	1	1/3	1/5	1/7	1/9
Memory	3	1	1/3	1/5	1/7
Camera	5	3	1	1/3	1/5

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

DSS	7	5	3	1	1/3
BBU	9	7	5	3	1

4.3 Construction of normalization matrix for above comparison matrix

The normalization matrix for above comparison matrix of criteria Profile, Situation, and Mobile Attributes are given in table 5, 6, 7 respectively.

Table 5 Normalization matrix for profile

	Address	**Occupation**	**Gender**	**Age**
Address	0.055	0.029	0.038	0.073
Occupation	0.167	0.088	0.050	0.093
Gender	0.278	0.265	0.152	0.167
Age	0.500	0.618	0.760	0.667

Table 6 Normalization matrix for the situation

	SCA	**PA**	**Location**	**Budget**
SCA	0.055	0.029	0.038	0.073
PA	0.167	0.088	0.050	0.093
Location	0.278	0.265	0.152	0.167
Budget	0.500	0.618	0.760	0.667

Table 7 Normalization matrix for mobile attributes

	Processor	**Memory**	**Camera**	**DSS**	**BBU**
Processor	0.040	0.020	0.026	0.030	0.060
Memory	0.120	0.061	0.034	0.053	0.076
Camera	0.200	0.184	0.105	0.070	0.137

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

DSS	0.280	0.306	0.313	0.212	0.180
BBU	0.360	0.429	0.522	0.635	0.547

4.4 Construction of weight matrix for criteria

The weight matrix for criteria Profile, Situation, and Mobile Attributes are given in table 8, 9, 10 respectively.

Table 8 Weight matrix for profile

Address	Occupation	Gender	Age
0.049	0.099	0.215	0.636

Table 9 Weight matrix for the situation

SCA	PA	Location	Budget
0.049	0.099	0.215	0.636

Table 10 Weight matrix for mobile attributes

Processor	Memory	Camera	DSS	BBU
0.035	0.689	0.139	0.258	0.499

4.5 Satisfaction degree of alternatives for criteria

The satisfaction degree matrix for the alternatives corresponding to each criterion that is considered in this experiment is given in table 11, 12, 13, 14, 15, 16, 17, 18, 19.

Table 11 Satisfaction degree for a profile of Apple

	EQC	MC	SC	VSC	EC
Address	0.50	0.37	0.07	0.03	0.03
Occupation	0.43	0.29	0.17	0.07	0.04

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

Gender	0.42	0.34	0.16	0.05	0.03
Age	0.40	0.38	0.08	0.10	0.04

Table 12 Satisfaction degree for a profile of Samsung

	EQC	**MC**	**SC**	**VSC**	**EC**
Address	0.23	0.26	0.22	0.16	0.13
Occupation	0.28	0.27	0.26	0.11	0.08
Gender	0.29	0.26	0.27	0.12	0.06
Age	0.24	0.28	0.25	0.15	0.08

Table 13 Satisfaction degree for a profile in Vivo

	EQC	**MC**	**SC**	**VSC**	**EC**
Address	0.24	0.25	0.32	0.08	0.11
Occupation	0.33	0.28	0.25	0.10	0.04
Gender	0.34	0.22	0.27	0.09	0.08
Age	0.36	0.28	0.22	0.08	0.06

Table 14 Satisfaction degree for the situation of Apple

	EQC	**MC**	**SC**	**VSC**	**EC**
SCA	0.39	0.32	0.22	0.04	0.03
PA	0.38	0.30	0.21	0.06	0.05
Location	0.35	0.28	0.29	0.03	0.05
Budget	0.37	0.29	0.19	0.08	0.07

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

Table 15 Satisfaction degree for the situation of Samsung

	EQC	MC	SC	VSC	EC
SCA	0.38	0.30	0.21	0.07	0.04
PA	0.39	0.28	0.24	0.05	0.04
Location	0.37	0.25	0.27	0.08	0.03
Budget	0.37	0.27	0.20	0.10	0.06

Table 16 Satisfaction degree for the situation in Vivo

	EQC	MC	SC	VSC	EC
SCA	0.32	0.22	0.24	0.15	0.07
PA	0.33	0.24	0.26	0.11	0.06
Location	0.30	0.28	0.29	0.04	0.09
Budget	0.28	0.25	0.26	0.12	0.09

Table 17 Satisfaction degree for mobile attributes of Apple

	EQC	MC	SC	VSC	EC
Processor	0.35	0.27	0.22	0.09	0.07
Memory	0.36	0.25	0.24	0.10	0.05
Camera	0.36	0.22	0.27	0.10	0.05
DSS	0.34	0.20	0.21	0.16	0.09
BBU	0.34	0.20	0.21	0.16	0.09

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

Table 18 Satisfaction degree for mobile attributes of Samsung

	EQC	MC	SC	VSC	EC
Processor	0.24	0.20	0.19	0.25	0.12
Memory	0.22	0.21	0.17	0.27	0.13
Camera	0.20	0.22	0.25	0.24	0.09
DSS	0.23	0.20	0.18	0.28	0.11
BBU	0.23	0.21	0.18	0.28	0.01

Table 19 Satisfaction degree for mobile attributes in Vivo

	EQC	MC	SC	VSC	EC
Processor	0.20	0.19	0.24	0.20	0.07
Memory	0.17	0.18	0.26	0.22	0.07
Camera	0.15	0.13	0.24	0.20	0.28
DSS	0.17	0.19	0.27	0.24	0.01
BBU	0.17	0.19	0.27	0.24	0.01

4.6 Calculation of usability value for criteria of alternatives

The usability value is calculated using weight matrix and satisfaction degree matrix for criteria Profile, Situation, and Mobile Attributes are given in table 20, 21, 22 respectively.

Table 20 Usability value for profile

Alternative	Usability Value
Apple	1.134
Samsung	0.999
Vivo	0.998

ISSN: 2321-8363
UGC Approved Journal
Impact Factor: 5.515

Table 21 Usability value for the situation

Alternative	Usability Value
Apple	0.999
Samsung	0.998
Vivo	0.930

Table 22 Usability value for mobile attributes

Alternative	Usability Value
Apple	0.998
Samsung	0.953
Vivo	0.898

4.7 Comparison of alternatives using usability value for criteria

The alternatives that are considered in this experiment are Apple, Samsung, and Vivo, which are compared on the basis of usability value for each criterion and ranked accordingly. Apple has the highest usability value and Vivo has the lowest usability value for each criterion so Apple is ranked on the top and Vivo is ranked on the bottom of priority level.

- **Profile**
  Apple(1.134) > Samsung(0.999) > Vivo(0.998)

- **Situation**
  Apple(0.999) > Samsung(0.998) > Vivo(0.930)

- **Mobile Attributes**
  Apple(0.998) > Samsung(0.953) > Vivo(0.898)

5. Conclusion

In this paper, the attributes are compared and ranked with the help of a questionnaire and AHP technique. The usability value for each attribute is calculated by taking satisfaction degree of that attribute and the weight matrix of each criterion into consideration. The usability value that has been obtained using AHP method for each attribute in the above experiment indicates that performance of Apple gives better result over other

Samsung and Vivo by approximately 6.135% and 10.793% respectively. Therefore, it may be derived that the most recommended mobile phone is Apple.

References

[1] Vanda Viljanac (2014) Recommender system for mobile applications, 2-5.
[2] Feature phone Definition from PC Magazine Encyclopedia, en.wikipedia.org.
[3] Todd Hixon, Two Weeks With A Dumb Phone, Forbes, November 13, 2012, en.wikipedia.org.
[4] "Apple's new iPhone to have a larger screen: Sources". The Times of India. Retrieved 16 May 2012, en.wikipedia.org.
[5] Jungah Lee; Lulu Yilun Chen (4 October 2013). "Samsung's Record Pressures Rivals as HTC Posts Loss". Bloomberg. Retrieved 5 October 2013, en.wikipedia.org.
[6] "Apple Sells 9 Million New iPhones In Opening Weekend". NPR. Retrieved September 23, 2013, en.wikipedia.org.
[7] Etherington, Darrell (July 25, 2013). "Apple Working On Location-Aware Battery Management For iPhone". TechCrunch. AOL. Retrieved June 25, 2017, en.wikipedia.org.
[8] "Vivo wants you to know its name so much it's sponsoring the World Cup". The Verge. Retrieved 4 June 2017, en.wikipedia.org.
[9] Top 10 smartphone makers in Q1 2015: Sony and Microsoft drop out of the picture, Chinese phone makers take over. Phonearena.com. Retrieved on 2017-01-03, en.wikipedia.org.
[10] Hu Yonghong. The Improvement of the Application of TOPSIS Method to Comprehensive Evaluation [J]. Mathematics in Practice and Theory, 32 (4), 572 – 575, 2002.
[11] Al-Azab FGM, Ayu MA (2010) Web-based multi-criteria decision making using AHP method. In: International conference on information and communication technology for the Muslim world (ICT4M), pp A6–A12.
[12] Bratati C, Roy S, Pattnaik PK (2014) User satisfaction metrics for cloud computing environment. Eur J Acad Essays 1(3):63–69.
[13] Roy S, Pattnaik PK (2013) Some popular usability evaluation techniques for websites. Adv Intell Syst Comput 247:535–543.
[14] Roy S, Pattnaik PK, Mall R (2016) Quality assurance of academic websites using usability testing: an experimental study with AHP. Springer j 8(1):1–11.
[15] P Matanhelia (2010) Mobile phone use by young adults in India: a case study, 15-20.
[16] DN Chen, Paul JH Hu, YR Kuo, TP Liang (2010) A Web-based personalized recommendation system for mobile phone selection: Design, implementation, and evaluation, 1-3.

Author Biography

Sweta Singh – pursuing Dual Degree (B.Tech & M.tech) in Computer Science Engineering at Kalinga Institute of Industrial Technology, research area interests are Cloud Computing and Data Analytics.

Prasant Kumar Pattnaik – a Senior faculty member in Computer Science Department at Kalinga Institute of Industrial Technology, research area interest is Cloud Computing, Distributed Computing, Data Analytics & Big Data.

