APPLICATION OF ANALYTIC HIERARCHY PROCESS (AHP) TO PRIORITIZE THE FACTORS INDIAN CONSUMERS CONSIDER WHILE BUYING SMART PHONES IN INDIA

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ABSTRACT

Smart phones have almost become a necessity for Indian mobile phone users. The study clearly identifies and prioritizes the features Indian consumers consider while purchasing smart phones in India. Analytic Hierarchy Process is a decomposition multiple-attribute decision making (MADM) method, in this study it has been used for ranking of the features present in smart phones. A mathematical model based on pair-wise comparison values has been developed by applying AHP. This paper provides relevant data to help the mobile phone manufacturing companies to focus on the features that Indian customers demand and at the same time make efforts to improve them in order to increase the sales of their smart phones in the country.

Keywords: Analytic Hierarchy Process, Features, Indian Consumers, Multi Attribute Decision Making (MADM)

I. INTRODUCTION

It is the era of information and technology and we are surrounded by many such gadgets and equipments which make our lives something more than easy. Smart phones are one such class of items which has totally revolutionized the way people used mobile phones even a decade ago. A smart phone is a cellular telephone with built-in applications and Internet access in addition to digital voice service, modern smart phones provide text messaging, e-mail, Web browsing, still and video cameras, MP3 player and video playback and calling **[1]**.They include functions similar to personal computers. Initially PDAs (personal digital assistant) were smart phones possessing calling features. But, nowadays the presence of added media- players, high resolution cameras, GPS, Wi-Fi are a must with any smart phone. Additionally, every smart phone these days have high-density screen resolution allowing the handsets to display various websites in their standard formats as they appear on our computer screens.

1.1 The Indian Smart Phone Scenario

Smart phones are no longer a gadget of luxury and sophistication they have now become a sensation in the Indian mobile phone market. India is ranked third among the top countries with smart phone users only behind China and USA with an estimated 118 million subscribers. A study by telecom equipment maker Ericsson shows that smart phone users in the country have among the highest rates of usage of smart phones daily globally, spending over three hours on an average on their devices. According to the study, Indian users spend 3 hours 18 minutes on average everyday with their smart phones while in the US, where the average is 132 minutes (2 hrs 12 mnts **[2]**.

Analytic Hierarchy Process is a decomposition multiple-attribute decision making (MADM) method. It is a method that can represent human decision making process and help in the achievement of better judgments based on hierarchy, pair-wise comparisons, judgment scales, allocation of criteria weights and selection of the best alternative from a finite number of variants by calculation of their utility functions. Subsequently, there has been a growth of applications and mathematical development to this methodology. The developments were focused on different parts of the method.

II. AIM OF THE RESEARCH

In this study we try to prioritize the factors the Indian consumers consider while purchasing smart phones. The Analytic Hierarchy Process (AHP) methodology has been used to determine the factors which play the most influencial role for Indian customers while buying smart phones. AHP is a mathematical and psychological decision making technique developed by T.L.Satty in the 1970s and has been widely studied and refined since then. The BPMSG AHP priority calculator online tool was used for obtaining preferences on criteria and alternatives for the determination of the relative priority of factors for smart phones in the Indian scenario.

III. REVIEW OF EXISTING LITERATURE

3.1 Smart phones

Hsiao and Chen did an empirical study on Smart phone demand and on the relationships between phone handset, Internet access, and mobile services, Their study explored the smart phone demand by emphasizing the differences between the three demand dimensions: (1) mobile or smart phone handset, (2) subscription to the 2G/3G network, and (3) mobile services, and then examined the relationship between them, and the effect of users' demographic characteristics on these three dimensions as well, by an empirical study in Taiwan **[3]**. Tseng and Lo in their study mentioned that the characteristics of the mobile/smart phone handset industry is multi-faceted; e.g., rapidly evolving nature with short product life-cycles **[4]**. Economides and Grousopoulou found that students tend to consider the following features important: battery life, mp3 player, video camera, photo camera, storage memory, Bluetooth, design and elegance, clock, calendar, organizer and reminder, while most of the respondents in their study do not consider the following important: touch screen, voice commands, chat, teleconference, encryption and cryptography, common use of files, printing **[5]**. Malviya et al. evaluated the factors influencing consumer's purchase decision towards smart phones in Indore. Using the confirmatory factor analysis model they concluded that people in Indore were buying Smart phones irrespective of its prices**[6]**. Lay-Yee et al. studied the factors affecting smart phone purchase decision among Malaysian generation Y **[7]**.

3.2 Analytic Hierarchy Process (AHP)

Dožić and Kalić applied AHP for aircraft selection process. By consideration of the selected criteria (aircraft seat capacity, aircraft price, total baggage, MTOW, payment conditions and CASM), various aspects of aircraft purchasing were covered, allowing airline's planner to choose the right aircraft from the set of alternatives. Their study showed that the AHP can be successfully used as a support tool in the decision making process related to aircraft selection problem, regarding criteria defined in their research **[8]**. Franek and Kresta in their research investigated the application and characteristics of different judgment scales developed by scholars for use in AHP. Results and their comparison showed that judgement scales played a significant role in AHP decision making **[9]**. Zuo et al. researched on the current situation of peasant-workers in construction industry

based on AHP. They concluded that the whole level of the peasant-workers' living was on the poor level. The indexes of the physiological need, the security need and the social need weighed high but obtained low scores. The indexes of the respected need and the self-realization need weighed low, but the comprehensive scores of the five indexes had no obvious difference, that means the peasant-workers in construction industry not only had physiological, security and social needs, but also had respected and self-actualization needs **[10]**.

Wang and Pan researched on the influence factors of Wuhan Housing Industry based on the AHP. They concluded that Government, enterprise, consumer and market were the key four factors of housing industrialization development in Wuhan through analysis and investigation and additionally they established an AHP structure model of influence factors to decide which factor was the most important one **[11]**. Tyagi et al. analysed the e-SCM performance by a hybrid approach using AHP-TOPSIS. Their research showed that the criteria 'improvement in production efficiency' and 'on time delivery' achieved higher priority weights **[12]**. Lijuan and Shinan made use of the approach of AHP for human factors analysis in the Aircraft Icing Accident.**[13]**. Khanmohammadi and Rezaeiahari did an AHP based classification of algorithm selection for clinical decision support system. In their study, a meta-learning algorithm was proposed to choose a machine learning classification algorithm that could be used for the development of CDSS **[14]**. Podgórski in his study demonstrated an AHP based study for selection of leading key performance indicators measuring operational performance of OSH management system. His paper presented a concept of making use of operationally focused minimum set of key performance indicators assigned to individual OSH MS components **[15]**.

IV. PROBLEM DESCRIPTION

Indian customers are very much choosy when it comes to purchasing smart phones. They are driven by a variety of factors starting from pricing, promotions and advertisements, durability, configuration, battery life, storage, camera resolution, connectivity options which are considered as the criteria in this study. The alternatives considered for this study are the affordability, design, brand, operating system (like Android, IOs, Windows etc.), functionality and user experience. Considering the selected criteria and the alternatives the analytical hierarchy process (AHP) has been applied.

V. METHODOLOGY OF RESEARCH

The study initiated by the identification of criteria and alternatives for the features Indian customers consider while purchasing Smart phones and selection of appropriate MADM methods. Depending upon the decision maker's inputs, the criteria weights were computed using the Analytic Hierarchy Process and additionally further computations were done to prioritize the factors while purchasing smart phones in the country. AHP is a Multi Attribute Decision Making technique and it is designed to incorporate tangible as well as intangible factors especially where the judgments are subjective for different individuals constitute an important part of decision making. A five step process is used in AHP to solve decision problems.

Analytic Hierarchy Process is a mathematical and psychological tool for the systematic analysis of expert opinions. Consultation with more experts helps avoid bias which may be found while considering the judgments of a single expert. The decision making for this study included people from all age groups who possess smart phones as well as from industry experts of the mobile phone sector . For the survey, Importance scale from 9 being Extremely Important to 1 being Equally Important was used to obtain the judgments. After building the matrix it becomes possible to compute the priority vector. Comparison between the elements based upon a

single entity for building the pairwise comparison matrices for the criteria with the pairwise comparison matrix for the alternatives helps in the computation of global and local priorities as well as ranking of the alternatives. The calculation of priorities from pairwise comparison matrices can be done in different ways which include:
(a) eigenvector method ; (b) geometric mean method ; (c) arithmetic average method

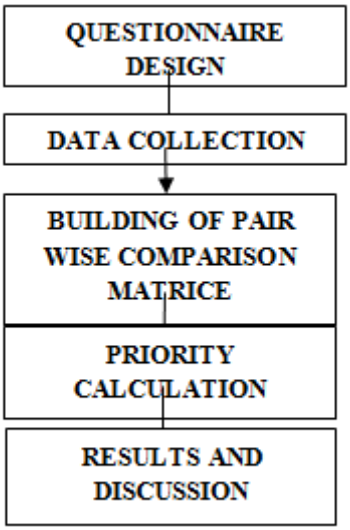

Figure 1 Methodology of Research

In this research we have used the eigenvector method proposed by Saaty(1980), according to whom the priority estimation of elements can be done by finding the principal eigen vector *w* of any matrix *M*, $Mw=\lambda_{max}w$, where λ_{max} is the maximum eigenvalue of matrix *M*. After nomalising vector *w*, it becomes the vector of priorities of elements. During building of each of pairwise comparison matrices involved in the decision making process, calculation of Consistency Ratio is necessary to check for consistency which is the ratio of Consistency Index (CI) and Random Index (RI).

$$\text{Consistency Index} = \frac{\lambda max - n}{n-1} \quad (1)$$

$$\text{Consistency Ratio} = \frac{CI}{RI} \quad (2)$$

The BPMSG AHP priority calculator online tool helped in obtaining the preferences on criteria and alternatives from the data collected for this study as well as the principal eigen value.

5.1 Questionnaire Design and Survey

In case of purchase of smart phones, pricing, durability, battery life, promotions and advertisements, camera resolution, configuration, storage and connectivity options are the main criteria which influence the features which customers consider while buying any smart phone in India. Thus the research objective is to prioritize the features related to smart phones while purchasing them from the Indian scenario. A country wide survey was conducted which included people from all age groups as well as industry experts from various mobile phone manufacturers. The medium of data collection was from online surveys and email, telephonic conversations, interview with company officials. The questionnaires was distributed among 2000 people nationwide from which 1981 positive responses were received which converted to percentage value comes to 99.05%. A successful survey is only possible when the questions are kept simple and to the point. This helps in the achieving valid, relevant and reliable data. Some of the sample questions have been tabulated below.

S.NO.	SAMPLE QUESTIONS	1	3	5	7	9
1	Smart phone should be Durable					
2	Battery-life has significance					
3	Pricing is considered while purchasing					
4	Camera resolution should be high					

Table 1 Sample Questionnaires

1: Equal Importance ; 3: Moderate Importance ; 5: Strong Importance ; 7: Very Strong Importance

9: Extreme Importance ; (2,4,6,8 are the values in between)

5.2 Establishment of the AHP Structure System

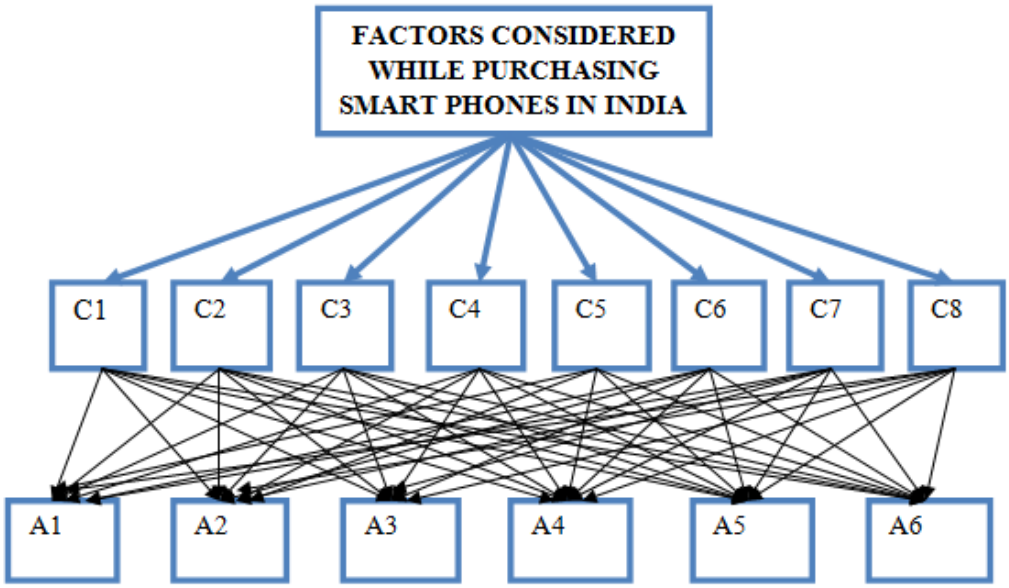

Figure 2. Hierarchial Structure

NOMENCLATURE OF CRITERIA & ALTERNATIVES

	CRITERIA
C1	**DURABILITY**
C2	**PRICING**
C3	**ADVERTISEMENTS AND PROMOTIONS**
C4	**BATTERY LIFE**
C5	**STORAGE**
C6	**CAMERA RESOLUTION**
C7	**CONNECTIVITY OPTIONS**
C8	**CONFIGURATION**
	ALTERNATIVES
A1	**AFFORDABILITY**
A2	**DESIGN**
A3	**BRAND**
A4	**OPERATING SYSTEM**
A5	**FUNCTIONALITY**
A6	**USER EXPERIENCE**

Table 2 Nomenclature Used In The Hierarchial Structure.

VI. RESULTS

6.1 Pairwise Comparison of Criteria

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Table 3. Random Inconsistency Index (RI) (Saaty 1980, Saaty1990)

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	Priority Vector
C1	1	5.00	8.00	1.00	3.00	0.20	5.00	0.41	0.124
C2	0.20	1	4.00	0.33	2.00	0.20	2.00	0.71	0.054
C3	0.12	0.25	1	0.25	0.50	0.14	1.00	0.12	0.024
C4	1.00	3.00	4.00	1	2.00	0.25	6.00	0.20	0.099
C5	0.33	0.50	2.00	0.50	1	0.33	4.00	0.17	0.053
C6	5.00	5.00	7.00	4.00	3.00	1	6.00	0.33	0.238
C7	0.20	0.50	1.00	0.17	0.25	0.17	1	0.17	0.026
C8	7.00	6.00	8.00	5.00	6.00	3.00	6.00	1	0.386

Table 4. Decision Matrix for Criteria

$\lambda max = 8.878$ *CR=0.09* *CI=0.125*

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	0.33	0.17	4.00	1.00	4.00	0.101
A2	3.00	1	1.00	8.00	3.00	9.00	0.301
A3	6.00	1.00	1	8.00	6.00	9.00	0.401
A4	0.25	0.12	0.12	1	0.17	2.00	0.035
A5	1.00	0.33	0.17	6.00	1	8.00	0.128
A6	0.25	0.11	0.11	0.50	0.12	1	0.026

Table 5. Decision Matrix for Alternatives with respect to Durability

$\lambda max = 6.345$ *CR=0.055* *CI=0.069*

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	6.00	0.33	3.00	4.00	7.00	0.0245
A2	0.17	1	0.17	0.50	0.14	1.00	0.038
A3	3.00	6.00	1	8.00	6.00	9.00	0.479
A4	0.33	2.00	0.12	1	1.00	3.00	0.079
A5	0.25	7.00	0.17	1.00	1	7.00	0.127
A6	0.14	1.00	0.11	0.33	0.14	1	0.031

Table 6. Decision Matrix For Alternatives With Respect To Pricing

λmax =6.517 CR=0.082 CI=0.1034

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	0.17	0.11	0.12.	0.11	0.33	0.023
A2	6.00	1	0.33	2.00	0.12	2.00	0.106
A3	9.00	3.00	1	4.00	0.50	7.00	0.272
A4	8.00	0.50	0.25	1	0.17	3.00	0.097
A5	9.00	8.00	2.00	6.00	1	6.00	0.453
A6	3.00	0.50	0.14	0.33	0.17	1	0.049

Table 7.Decision Matrix for Alternatives With Respect To Advertisement and Promotions

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	3.00	1.00	0.33	0.11	0.12	0.056
A2	0.33	1	0.25	0.17	0.12	0.17	0.030
A3	1.00	4.00	1	1.00	0.14	0.20	0.081
A4	3.00	6.00	1.00	1	0.33	0.50	0.135
A5	9.00	8.00	7.00	3.00	1	1.00	0.382
A6	8.00	6.00	5.00	2.00	1.00	1	0.316

λmax =6.465 CR=0.074 CI=0.093

Table 8. Decision Matrix For Alternatives With Respect To Battery Life

λmax =6.326 CR=0.052 CI=0.0652

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	8.00	0.500	4.00	0.25	3.00	0.158
A2	0.12	1	0.12	0.33	0.11	0.25	0.025
A3	2.00	8.00	1	8.00	0.25	2.00	0.221
A4	0.25	3.00	0.12	1	0.14	1.00	0.052
A5	4.00	9.00	4.00	7.00	1	6.00	0.471
A6	0.33	4.00	0.50	1.00	0.17	1	0.073

Table 9. Decision Matrix for Alternatives with respect to Storage.

λmax =6.410 CR=0.065 CI=0.082

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	4.00	0.50	0.50	8.00	7.00	0.232
A2	0.25	1	0.12	0.14	2.00	1.00	0.052
A3	2.00	8.00	1	0.50	5.00	2.00	0.256
A4	2.00	7.00	2.00	1	6.00	6.00	0.359
A5	0.12	0.50	0.20	0.17	1	1.00	0.042
A6	0.14	1.00	0.50	0.17	1.00	1	0.058

Table 10. Decision Matrix for Alternatives with respect to Camera resolution

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	1.00	0.11	0.12	0.50	0.12	0.035
A2	1.00	1	0.12	0.12	0.50	0.25	0.043
A3	9.00	8.00	1	1.00	2.00	1.00	0.274
A4	8.00	8.00	1.00	1	3.00	0.50	0.262
A5	2.00	2.00	0.50	0.33	1	0.50	0.101
A6	8.00	4.00	1.00	2.00	2.00	1	0.283

$\lambda max = 6.408$ *CR=0.065* *CI=0.081*

Table 11. Decision Matrix for Alternatives with respect to Configuration

$\lambda max = 6.201$ *CR=0.0323* *CI=0.0402*

Alternative	A1	A2	A3	A4	A5	A6	Priority vector
A1	1	7.00	1.00	2.00	0.11	2.00	0.122
A2	0.14	1	0.25	0.12	0.11	1.00	0.031
A3	1.00	4.00	1	1.00	0.11	2.00	0.093
A4	0.50	8.00	1.00	1	0.12	1.00	0.096
A5	9.00	9.00	9.00	8.00	1	7.00	0.601
A6	0.50	1.00	0.50	1.00	0.14	1	0.057

Table 12. Decision Matrix for Alternatives with respect to Connectivity options

$\lambda max = 6.622$ *CR=0.099* *CI=0.1244*

	Durability	**Pricing**	**Advertisement and promotions**	**Battery life**	**Storage**	**Camera resolution**	**Connectivity options**	**Configuration**	**Global Priority weights**
	(0.124)	**(0.054)**	**(0.024)**	**(0.099)**	**(0.053)**	**(0.238)**	**(0.026)**	**(0.386)**	
Affordability	0.101	0.0245	0.023	0.056	0.158	0.232	0.122	0.035	***0.1002***
Design	0.301	0.038	0.106	0.030	0.025	0.052	0.031	0.043	***0.0759***
Brand	0.401	0.479	0.272	0.081	0.221	0.256	0.093	0.274	***0.2709***
Operating system	0.035	0.079	0.097	0.135	0.052	0.359	0.096	0.262	***0.2161***
Functionality	0.128	0.127	0.453	0.382	0.471	0.042	0.601	0.101	***0.1609***
User Experience	0.026	0.031	0.049	0.316	0.073	0.058	0.057	0.283	***0.1657***

Table 13 Global Priority Weights for Alternatives With Respect To the Chosen Criteria

ALTERNATIVES	**GLOBAL PRIORITY WEIGHTS**	**RANKING**
Affordability	**0.1002**	**5**
Design	**0.0759**	**6**
Brand	**0.2709**	**1**
Operating system	**0.2161**	**2**
Functionality	**0.1609**	**4**
User Experience	**0.1657**	**3**

Table 14 Ranking of Alternatives With Respect To Global Priority Weights Calculated

VII. CONCLUSIONS AND SCOPE FOR FUTURE WORK

Selection and prioritizing of features related to Smart phones in the Indian mobile phone market is a very important development which will help the companies to identify the specific features to cater to the needs of the Indian customers. India being third in the Smart phone users list globally certainly acts as a lucrative trading zone for the leading Smart phone producers in the world. Smart phones today have more than expected features

to offer to the customers but what Indian customers want has been the main concern in this research. Thus it can be concluded that the feature which Indian customers consider while purchasing smart phones is the Brand of the Smart phones. It is followed by the Operating system such as Android, Windows, IOs, etc., and then comes User experience functionality and so on. The feature which least affects the buying decision of Indian Smart phone buyers is the Design of Smart phones compared to all these given features. In the present advancement of Smart phone technology Affordability which earlier used to be a great determinant of purchasing decision is now on the lower side of the rankings. Analytic Hierarchy Process has been put into use for the calculation of the global priority weights of the Alternatives with respect to the Criteria considered for this study. The results seem pretty much satisfactory matching Smart phone buying trend among Indian customers belonging to different age groups. Hence by the application of AHP for the analysis of features affecting the Smart phone buying decision of Indian customers, it has been found that Brand is the best alternative. With such rapid development of new technology in the area of Smart phones in near future the present trend may change and considering these features along with many more added features, other statistical decision-making methods apart from AHP may be implemented for this study to obtain results showing the future trends.

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