Analytical Hierarchy Process for Higher Effectiveness of Buyer Decision Process

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GJMBR Classification
FOR: 150501, 150502, 150505 & 150503
GJEL: D11

***Abstract*- Buyer decision processes are the decision-making processes undertaken by consumers about a potential market transaction before, during, and after the purchase of a product or service. More generally, decision-making is the cognitive processes of selecting a course of action from among multiple alternatives. How many evaluation criteria a consumer will use, what different types of criteria will be considered and how much importance will be placed on each of them depends on the consumer himself and the product consideration. The Analytical Hierarchy Process (AHP) is a multi criteria decision-making process that is especially suitable for complex decisions, which involve the comparison of decision elements, which are difficult to quantify. The crux of AHP is the determination of the relative weights to rank the decision alternatives. In this study, it has been identified that through using AHP model consumers can evaluate the product attributes differently from simple evaluation criteria. AHP process described an effective buying decision by finding out the effectual attributes of different alternatives.**

Keywords:Analytical hierarchy process, Buying decision process, MCDM, Purchase behavior

I. Introduction

Consumer buying behavior is very complex and it may vary greatly across different types of products and buying decisions. Consumers use different criteria and attributes in the decision process especially in the evaluation stage. Analytical Hierarchy Process (AHP) is such a tool that can be used to evaluate buyer decision process more effectively and efficiently.

Buying Decision Process: Consumer buying decision produces an image of an individual carefully evaluating the attributes of a set of products, brands, or services and rationally selecting the one that solves a clearly recognized need for the least cost (Hawkins, 2007). Marketers have to go beyond the various influences on buyers and develop an understanding of how consumers actually make their buying decisions. Specially, marketers musty identify who makes the buying decision, the types of buying decisions, and the steps in the buying process.

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tages of the Buying Decision Process: Smart companies will immerse themselves in trying to understand the customer's overall experience in learning about a product,

making a brand choice, using the product, and even disposing of it. Market scholars have developed a "stages model" of the buying decision process. The consumer passes through five stages: problem recognition, information search, evaluation of alternatives, purchase decision and post purchase behavior (Kotler, 2006).

Problem Recognition: The buying process starts when the buyer recognizes the problem or need. The need can be triggered by external or internal stimuli. Marketers need to identify the circumstances that trigger a particular need. By gathering a number of information from a number of customers, marketers can identify the most frequent stimuli that spark an interest in a product category. They cam develop marketing strategies that trigger consumer interest.

Information Search: An aroused customer will be inclined to search for more information. The relative amount and the influences of the information sources vary with product category and the buyer's characteristics. Each information sources perform a different function in influencing the buying decision. Through gathering information, the customers learn about competing brands and their features.

Evaluation of Alternatives: There are several decision evaluation processes, the most current models of which see the process as cognitively oriented. Consumers vary as to which product attributes they see as most relevant and the importance they attach to each attributes. They will pay the most attention to attributes that deliver the sought benefits.

Purchase Decision: In the evaluation stage, the consumers form preferences among the brands in the choice set. The consumer may also form an intension to buy the most preferred brand. Attitude of others and unanticipated situational factors can intervene between the purchase intension and the purchase decision.

Post purchase Behavior: After purchasing the product, the consumer will experience some level of satisfaction or dissatisfactions. The marketer's job does not end when the product is bought. Marketers must monitor post purchase satisfaction, post purchase actions and post purchase product use.

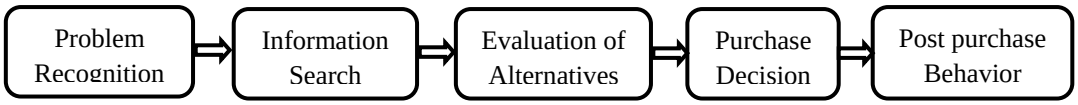


Figure 1: Five-Stage Model of Consumer Buying Process

The AHP is a comprehensive framework when multiobjective, multicriterion and multifactor decisions are made. In this paper, AHP is used to increase the effectiveness of the concept of buying decision process. This method was applied to clarify the concept of buying and to focus the strategy to the most essential issues.

II. Literature Review

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach and was introduced by Saaty (1977). The analytical hierarchy process (AHP) has proven to be a useful method for decision making (Saaty 1980). The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP is a decision support tool which can be used to solve complex, unstructured decision problems (Partovi, 1994). It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives.

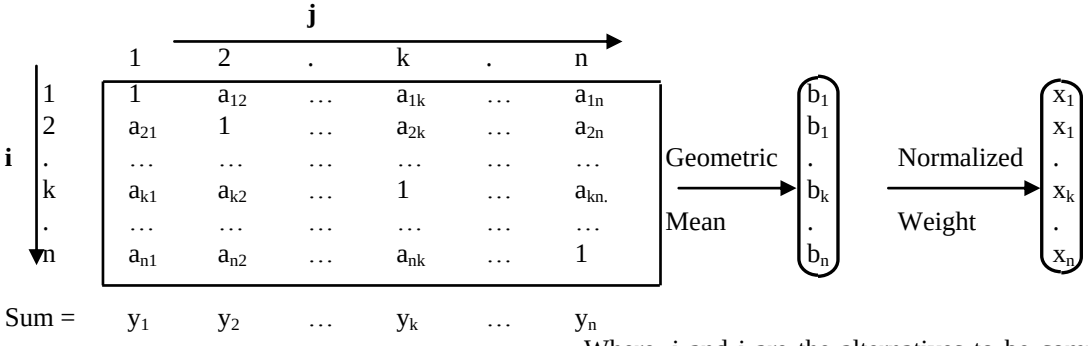
Some of the industrial engineering applications of the AHP include its use in integrated manufacturing (Putus, 1990), in the evaluation of technology investment decisions (Boucher and McStravic, 1991), in flexible manufacturing systems (Wabalickis, 1998), layout design (Cambron and Evans, 1991), location planning of airport facilities and international consolidation terminals (Min, 1994), large and complex project such as the "Silverlake Project" (Bauer et al, 1992), software development (Finnie et al, 1993), supplier selection (Iqbal, 2004), selection of alternative communication media (Quamruzzaman, 2002) and also in other engineering problems (Wang and Raz, 1991). It can be applied to contribute understanding in various types of decision problems (Arbel and Orhler, 1990; Hämäläinen, 1990; Srinivasan and Bolster, 1990;).

A. Theory of Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) organises the basic rationality by breaking down a problem into its smaller constituent parts. By decomposing the problem, the decision-maker can focus on a limited number of items at the same time. The AHP is carried out in two phases: the design of the hierarchy and the evaluation of the components in the hierarchy (Saaty, 1980 and Vargas, 1990).

The Analytical Hierarchy Process (AHP) is a multi criteria decision making process that is especially suitable for complex decisions which involve the comparison of decision elements which are difficult to quantify. It is based on the assumption that when faced with a complex decision the natural human reaction is to cluster the decision elements according to their common characteristics. It is a technique for decision making where there are a limited number of choices, but where each has a number of different attributes, some or all of which may be difficult to formalize. It is especially applicable when a team is making decisions. It involves building a hierarchy (Ranking) of decision elements and then making comparisons between each possible pair in each cluster (as a matrix). This gives a weighting for each element within a cluster (or level of the hierarchy) and a consistency ratio (useful for checking the consistency of the data).

The crux of AHP is the determination of the relative weights to rank the decision alternatives. Assuming that there are n criteria at a given hierarchy, the procedure establishes an n × n pair-wise comparison matrix, A, that reflects the decision maker's judgment of the relative importance of the different criteria. The pair-wise comparison is made such that the criterion in row i (i = 1,2,3,....,n) is ranked relative to each of the criteria represented by the n columns. Letting aij define the element (i,j) of A, AHP uses a discrete scale from 1 to 9 in which aij = 1 signifies that i and j are equally important, aij = 5 indicates that i is strongly more important than j and aij = 9 indicates that i is extremely more important than j. Other intermediate values between 1 and 9 are interpreted correspondingly. For consistency, aij = k automatically implies that aji = 1/k. Also all the diagonal elements aii of A must equal 1 because they rank a criterion against itself. The relative weights of criterion can be determined from A by dividing the elements of each column by the sum of the elements of the same column. The resulting matrix is called normalized matrix, N.



The numerical results of attributes are presented to the decision maker to assign relative importance according to a predefined scale. Now a judgment matrix prepared. It is an (n × n) matrix; normalized weights are calculated

Where, i and j are the alternatives to be compared. a_{ij} is a value that represent comparison between alternatives or attributes i and j. The above judgment matrix may be consistent if $a_{ij} . a_{jk} = a_{ik}$. For all values of i, j, k, in the above

judgment matrix, sum of the element in a column, $y_k = \sum a_{ij,}$ where, i = 1,2, ….. n and j = 1,2, …… n

Geometric mean is calculated as, $b_k = [(a_{k1}). (a_{k2})……..(a_{kn})]^{1/n}$, where, k = 1, 2, …… n

Normalized weights are calculated as, $X_k = \frac{b_k}{\Sigma b_k}$

Acceptability of alternative or attribute is measured in terms of Consistency Ratio (C.R.)

Consistency ratio = consistency index / randomly generated consistency index

Atty's measure of consistency is done in terms of Consistency Index (C.I.) C.I.= $\frac{\lambda_{max - n}}{n-1}$

where, $\lambda_{max} = y_1x_1 + y_2x_2 + …….+ y_kx_k. …….+y_nx_n = \sum y_kx_k$ = largest eigen value of matrix of order n

Now, some Randomly Generated Consistency Index (R.I.) values are as follows:

n	1	2	3	4	5	6	7	8	9	10
R. I.	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

If C.R. < 10%, then the level of inconsistency is acceptable. Otherwise, the alternative or attribute is rejected. The over-all consistency may also be measured to justify the validity of selection. It has been tried to find out a systematic approach of buying decision process using this AHP tool.

III. PROBLEM DEFINITION

The consumers arrive at attributes toward the various brands through an attribute evaluation procedure. Suppose that a consumer has narrowed his choice set to four computers (A, B, C and D) (Kotler, 2006). Assume that he is interested in four attributes, memory capacity, graphics capacity, size and weight and price. Table shows his belief about each brand rates on the four attributes. Most buyers consider several attributes in their purchase decision. Suppose he assigned 40 percent of the importance to the computer's memory capacity, 30 percent to the graphics capacity, 20 percent to the size and weight and 10 percent to the price. The weight for each attribute is then multiplied by the performance score that is assigned. Finally, these products are summarized to determine final rating for alternatives.

Table 2: A Computer's Brand Beliefs about Customers

Computer	Attributes				Scores
	Memory Capacity	Graphics Capacity	Size and Weight	Price	
A	10	8	6	4	8.0
B	8	9	8	3	7.8
C	6	8	10	5	7.3
D	4	3	7	8	4.7
Weight	0.40	0.30	0.20	0.10	

Therefore, the consumer will favor computer A, which (at 8.0) has the highest perceived value. The major limitation of this approach is that it is difficult to effectively take qualitative evaluation criteria into consideration. Memory capacity, graphics capacity, size and weight and price are strongly related to each other. However, in the above evaluation process the relation between the attributes has not been considered. This evaluation process can be effectively modified using Analytic Hierarchy Process (AHP), which is a Multi Criteria Decision Making (MCDM) technique.

IV Evaluating Buyer Decision Process through AHP Model

The Analytical Hierarchy Process is a Multi Criteria Decision Making (MCDM) techniques, where both quantitative and qualitative performance factors are considered to select an alternatives. As buyer decision process involves several qualitative and quantitative criteria. The qualitative criteria are judged by expert opinions, whereas quantitative criteria are udged against the collected data and calculated quantitative criteria.

The above example is assessed by Analytical Hierarchy Process to increase the effectiveness of buying decision process by evaluating the alternatives considering the both quantitative and qualitative performance factors.

For pair-wise comparison, i.e. relative importance of one option over other is done using a scale of relative

importance. For example, if the consumer believes that memory capacity is moderately more important than

price, then this judgment is represented by a 3. Judgments are required for all the criterion comparisons, and for all the alternative comparisons for each criterion. The consumer has to develop a set of pair wise comparisons to define the relative importance of the criteria to complete the matrix. Preference weight values for different level of importance are shown in Table 3.

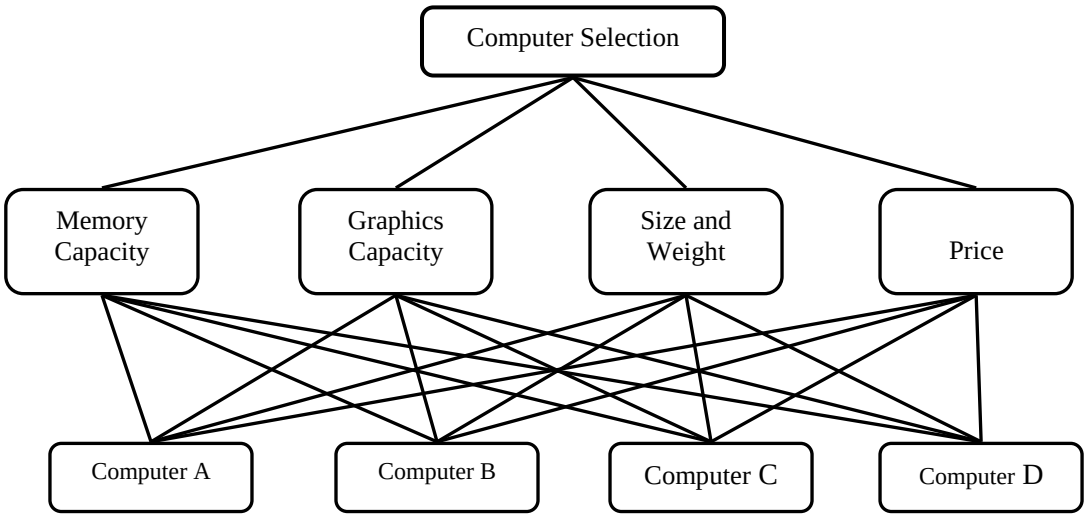


Figure 2: Evaluating Buyer Decision Process through AHP Model

Table 3: Level of Preference Weight For AHP

Level of importance/ preference weights	Definition	Explanation
1	Equally Preferred	Two activities contribute equally to the objective
3	Moderately	Experience and judgment slightly favor one activity over another
5	Strong importance	Experience and judgment strongly or essentially favor one activity over another
7	Noticeable dominance	An activity is strongly favored over another and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest degree possible of affirmation
2,4,6,8	Intermediate values	Used to represent compromise between the preferences listed above
Reciprocals	Reciprocals for inverse comparison	

Table 4: Evaluation at Level 1

Attributes	Memory Capacity	Graphics Capacity	Size and Weight	Price	Geometric Mean	Normalized Weight
Memory Capacity	1	3	5	1	1.967989	0.43017
Graphics Capacity	1/3	1	4	2	1.074569	0.23488
Size and Weight	1/7	1/5	1	1/5	0.274941	0.06009
Price	1	1/2	5	1	1.257433	0.27486
Sum	2.476	4.7	15	4.2	4.574932	1

For the assignments in the above judgment matrix, n= 4, λ_{max}= 4.224798
Consistency Index (C.I.) = 0.07493
Randomly Generated Consistency Index (R.I.) = 0.9

Consistency Ratio (C.R.) = 0.083258 = 8.3258%, So, acceptable

Table 5: Evaluation at Level 2 for Memory Capacity

	Computer A	Computer B	Computer C	Computer D	Geometric Mean	Normalized Weight
Computer A	1	10/8	10/6	10/4	1.510763	0.389817
Computer B	8/10	1	8/6	8/4	0.854039	0.220365
Computer C	6/10	6/8	1	6/4	0.906413	0.233879
Computer D	4/10	4/8	4/6	1	0.604351	0.155939
Sum	2.8	3.5	4.664	5.5	3.875566	1

n= 4, λ_{max}= 3.811241, C.I. = 0
R.I. = 0.9, Consistency Ratio (C.R.) = 0%, So, acceptable

Table 6: Evaluation at Level 2 for Graphics Capacity

	Computer A	Computer B	Computer C	Computer D	Geometric Mean	Normalized Weight
Computer A	1	8/9	8/8	8/3	1.240535	0.285695
Computer B	9/8	1	9/8	9/3	1.395907	0.321477
Computer C	8/8	8/9	1	8/3	1.240535	0.285695
Computer D	3/8	3/9	3/8	1	0.465186	0.107132
Sum	3.5	3.109	3.5	9.334	4.342163	1

n= 4, λ_{max}= 3.999307, C.I. = 0
R.I. = 0.9, Consistency Ratio (C.R.) = 0% So, acceptable

Table 7: Evaluation at Level 2 for Size and Weight

	Computer A	Computer B	Computer C	Computer D	Geometric Mean	Normalized Weight
Computer A	1	6/8	6/10	6/7	0.78804	0.193543
Computer B	8/6	1	8/10	8/7	1.050731	0.258061
Computer C	10/6	10/8	1	10/7	1.313389	0.32257
Computer D	7/6	7/8	7/10	1	0.919484	0.225826
Sum	5.167	3.875	3.1	4.428	4.071644	1

n= 4, λ_{max}= 3.999948, C.I. = 0
R.I. = 0.9, Consistency Ratio (C.R.) = 0%, So, acceptable

Table 8: Evaluation at Level 2 for Price

	Computer A	Computer B	Computer C	Computer D	Geometric Mean	Normalized Weight
Computer A	1	4/3	4/5	4/8	0.854521	0.199985

Computer B	3/4	1	3/5	3/8	0.640931	0.149998
Computer C	5/4	5/3	1	5/8	1.068271	0.250009
Computer D	8/4	8/3	8/5	1	1.709201	0.400008
Sum	5	6.667	4	2.5	4.272924	1

n= 4, λ_{max}= 4.000019, C.I. = 0.00000633

R.I. = 0.9, Consistency Ratio (C.R.) = 0.000703%, So, acceptable

Based on the above matrices, an overall evaluation is performed using the calculated weights of the alternatives and four measuring criteria, as follows:

Table 14: Final Evaluation for Analytic Hierarchy Process (AHP)

Alternatives	Attributes and their Weights				Composite Weight	Over-all Ranking
	Memory Capacity	Graphics Capacity	Size and Weight	Price		
	0.43017	0.23488	0.06009	0.27486		
Computer A	0.389817	0.285695	0.193543	0.199985	0.301389	1
Computer B	0.220365	0.321477	0.258061	0.149998	0.227038	3
Computer C	0.233879	0.285695	0.32257	0.250009	0.255812	2
Computer D	0.155939	0.107132	0.225826	0.400008	0.215759	4

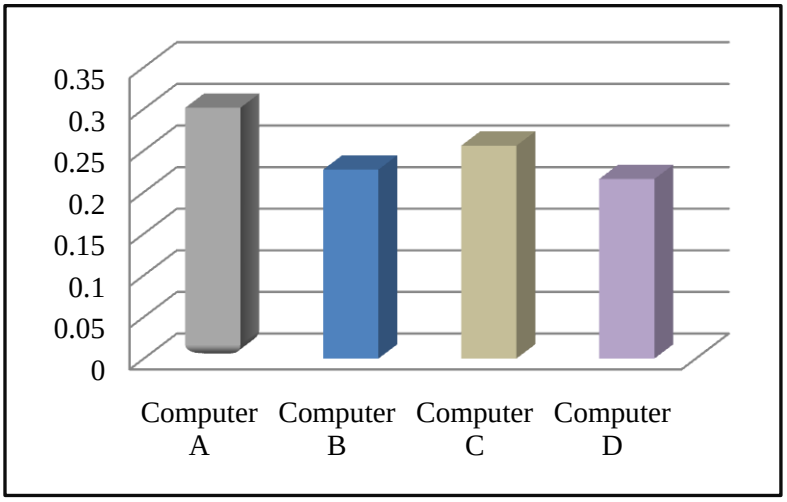


Figure 3: Decision Analysis Graph

IV. Conclusions

Buying process starts long before the actual purchase and has consequences long afterward. Evaluation of alternatives is a vital and critical stage of an effective buying process. Analytical Hierarchy Process can be an effective tool for evaluation of alternatives for buying decision process. AHP has been engaged to improve and support individual decision making about buying process. The Multi Criteria Decision Making process described in this paper ensures that effective buying decision can be possible by finding out the effectual attributes of different alternatives by the consideration of both quantitative and qualitative performance factors.

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