International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869 (O) 2454-4698 (P), Volume-6, Issue-2, October 2016

An Analytical Hierarchy Process Application in Smartphone Selection

Suat Kasap, Abdullah Atyani

***Abstract*— Making rational decisions is necessary to obtain better desired consequences and reduce the risks. Decision making is a cognitive task that requires thinking, diagnosing, evaluating, and choosing. The purpose of this paper is showing how the cognitive tasks could be analysed. When multiple objectives are important to a decision maker, it may be difficult to choose between alternatives. In such a case Thomas Saaty's Analytic Hierarchy Process (AHP) provides a powerful tool that can be used to make decisions in situations involving multiple objectives. In thıs paper, the AHP model is used as a tool to illustrate as a scientific way of decision making. A comprehensive background about the AHP model and a complete application of the model is introduced to choose the best smartphones according to different criteria. Currently, there are too many smartphones to select from many models to enumerate, made by many different manufacturers and running under different operating systems. Selecting the right one can be a challenge, since there is no answer that one size fits all. It's important to focus about exactly what you'll be doing most often with the phone, and what criteria are most important to you because it's likely you'll have to make a trade-off somewhere. At this point, AHP is multi criteria decision making method that helps the individuals to make smartphone selection where the alternatives are many, and the selection criteria are complex. In this paper, an AHP is applied to the selection of the best smartphone among multiple smartphone brands. The steps of designing the experiment and adopting it is shown along with the final results that will help in making the final decision.**

***Index Terms*—Analytic Hierarchy Process (AHP), Decision analysis and methods; Multi-criteria decision making; Operations research; Selection problem.**

I. INTRODUCTION

Decision making is a very complex process that requires a lot of information processing. Humans tend to make decisions on a daily basis. These decisions vary in complexity according to their impact. Taking a life changing decision like getting married is different from choosing between multiple cars to buy. It is also different from choosing which way to take to school every day. Each decision requires a certain amount of time and effort to be made. However, they all share a common feature. Any situation that requires making a decision has multiple alternatives. People diagnose each alternative and compare between the consequences to make the right decision. However, some people rely on assumptions and expectations to choose an alternative. Looking at the situation form a scientific view, decision making is an information processing task. It is a cognitive task that requires thinking, diagnosing, evaluating, and choosing. This means that making a decision could be done scientifically, and based on scientific tools and techniques. When multiple objectives are important to a decision maker, it may be difficult to choose between alternatives. In such a case Thomas Saaty's analytic hierarchy process (AHP) provides a powerful tool that can be used to make decisions in situations involving multiple objectives. The AHP is one of the most known and applied techniques in analyzing the process of making a decision in a scientific way that simplifies the process and make it clear in terms of numbers and weighs given for each alternative.

Nowadays, there are too many smartphones to select from many models to enumerate, made by many different manufacturers and running under different operating systems. Selecting the right one can be a challenge, since there is no answer that one size fits all. It's important to focus about exactly what you'll be doing most often with the phone, and what criteria are most important to you because it's likely you'll have to make a trade-off somewhere. At this point, AHP is multi criteria decision making method that helps the individuals to make smartphone selection where the alternatives are many, and the selection criteria are complex. In this paper, an AHP is applied to the selection of the best smartphone among multiple smartphone brands.

Suat Kasap, Industrial Engineering Department, American University Of The Middle East – AUM, Egaila, Kuwait, +965 9005 4122
Abdullah Atyani, Industrial Engineering Department, American University Of The Middle East – AUM, Egaila, Kuwait, +965 9997 1256

II. BACKGROUND THEORY

The Analytic Hierarchy Process (AHP) is a type of structured technique to choose between multiple alternatives based on multiple criteria. The technique was developed in the 1970s by Thomas L. Saaty [1]. Simply saying, when the person has multiple things to choose from, and his decision is based on defined criterion, the AHP model is applicable. The method is widely used in different fields like education, healthcare, quality assessment, customer requirements, business management, etc. It can be used to choose from multiple options, or to rank alternatives, or to allocate resources properly, or to compare between competitors, or to settle a conflict [2], [3], [4], [5], and [6].

The AHP model is coded into many software programs where the users can input the variables of their study to obtain the required outputs. Benefits and limitations of the AHP are examined with the several applications [2]. An AHP application in vendor selection problem is illustrated [3]. In another study, the AHP model was used to measure the importance of different projects with respect to the resources of an organization in order to prioritize the projects and allocate the resources properly [4]. Another study explains the usage of AHP in making decisions by measuring intangible impacts of building the Trans-Sumatra Highway in Indonesia. Using the AHP, the social impact of building the highway was added to the cost-benefit analysis [5]. A recent article proposed a new way of evaluating the sports

marketing, the marketing done in sports events [6]. The SWOT analysis was mainly used to evaluate the available alternatives in this industry. This study suggests a new model of evaluation based on the SWOT and AHP models together. The methodology proposed using the AHP model to test the main factors introduced in the SWOT analysis. Factors like competition, financial income, and media coverage were analyzed and prioritized according to the AHP model to see how they affect the sports marketing.

The theory behind implementing the AHP in measuring intangible factors that affect the decision making process is discussed [7]. How the priorities are driven form comparison judgment between multiple factors are shown. In another application by Saaty [8] a detailed description of a job selection process, where criteria of selection were flexibility, opportunity, security, reputation, and salary are illustrated.
The method is well-structured, and it has a set of defined steps to be followed. It starts with modelling the decision to be made, the alternatives, and the selection criterion in a hierarchy. Once the hierarchy is ready with the three levels; goal, criteria, alternatives, comparisons are made. The alternatives are compared in pairs against each of the criterion to be prioritized. Numbers are used to conducts the comparisons. The obtained numbers are then processed to obtain relative priorities for each element. These priorities are absolute numbers between zero and one without dimensions. Finally, these priorities are aggregated to generate evaluation metrics for each of the alternatives. Decision is then made based on the results of the study.

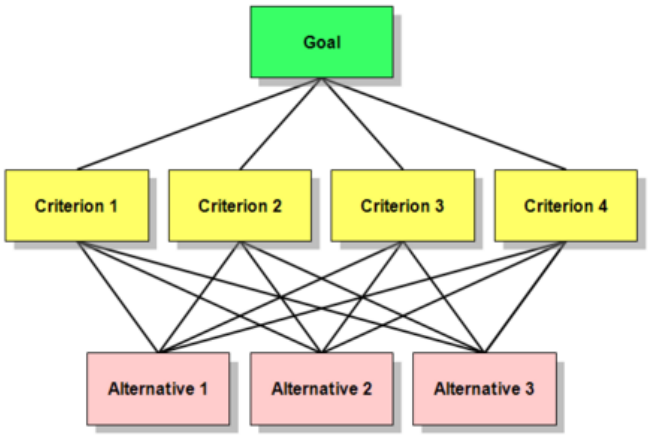

Fig. 1. AHP Model Structure

Fig. 1 illustrates the general hierarchy of the model. The number of criteria and alternatives can vary according to the situation. The advantage of the method is that it can be used in multiple situations, and it has a well-defined structure. The complexity of application increases with the increase in number of alternatives and criteria.

III. Methodology

The DAMES methodology, where D=Define the problem, A=Analyze, M=Make search, E=Evaluate alternatives, and S=Specify and sell solution, one of the most common techniques in implementing engineering projects, is implemented throughout the study [9].

Define: The first step is clearly defining the problem. This paper focuses on implementing a scientific way of making decisions. It introduces the AHP model, and adopts it to make a decision regarding a real life situation. The situation under study is making a decision on which smartphone to buy based on different criteria. The smartphones under study are defined as A, B, and C. These alternatives will be evaluated based on the following criteria: price, battery life, camera features, and display features [10].

Analyze: The second step after defining the problem is analyzing it and setting objectives. The main objective of this study is reaching a decision regarding the smartphone selection process. It also aims at making the decision making process more reliable because it is based on scientific analysis.

Make search: The third step is making search about the AHP model itself. How is it applied? In what situations is it practical? What are the most important selection criteria to be followed in this study? What are the alternatives to choose from? The theoretical background and literature review helps in answering the previous questions in order to make the implementation phase clearer.

Evaluate alternatives: After constructing a good background about the problem, it is time to evaluate the different approaches in solving it. In this study, the AHP model has already been chosen to make the decisions. However, some alternatives were analyzed regarding the selection criteria and alternatives. The available smartphones in the market are many, and choosing a group of them to conduct the study was challenging. Similarly, the selection criteria for smartphones are many. People differ on how they evaluate the smartphone before buying it, so the criteria must be chosen wisely.

Specify and sell solution: Finally, different websites offering comparisons between the smartphones in the market were visited to determine the best smartphone choices based on the customers' reviews. The selection criteria were also analyzed to determine which features mostly affect the decision of the buyer.

IV. Implementation

In this study, an AHP model on a real life situation that requires making decision for the smartphone selection problem is designed to implement. The following steps represent the design of the experiment conducted in this paper in details:

1. Introducing the alternatives with a brief description about each selection criterion. Table 1 provides alternatives (A, B, and C) with description for each criterion such as price, battery, camera, and display features [10].

Table 1. Features of the smartphones

	A	*B*	*C*
C1-Price	$430	$584	$749
C2-Battery	20 hours 3000 mAh	20 hours 2600 mAh	T24 hours 2750 mAh
C3-Camera	Rear: 16 MP Front: 8 MP	Rear: 16 MP Front: 5 MP	Rear: 12 MP Front: 5 MP
C4-Display	5.5 Inch 2560 × 1440 Add. D Support	5.1 Inch 2560 × 1440	5.5 Inch 1920 × 1080 3D touch

2. Building the decision hierarchy represented by Fig. 2.

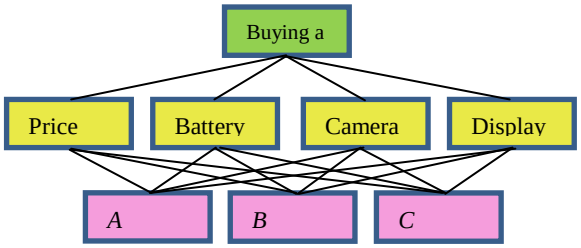

Fig. 2. An AHP model to smartphone selection

3. Making pairwise comparisons between the alternatives based on a fundamental scale represented in Table 2.

Table 2. The fundamental scale for pairwise comparisons

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment moderately favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities of 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

4. The comparisons are first made between the alternatives with respect to each criterion, given in Table 3, 4, 5, and 6.

Table 3. Alternatives compared with respect to Price

A	3	B	1
A	7	C	1
B	4	C	1

Table 4. Alternatives compared with respect to Battery

A	4	B	1
A	2	C	1
B	1	C	3

Table 5. Alternatives compared with respect to Camera

A	3	*B*	1
A	4	*C*	1
B	1	*C*	2

Table 6. Alternatives compared with respect to Display

A	3	*B*	1
A	5	*C*	1
B	4	*C*	1

5. Other comparisons are made to determine the value of each criterion with respect to the goal of the study, given in Table 7.

Table.7 Criteria compared with respect to the goal

Price	1	Battery	3
Price	1	Camera	5
Price	1	Display	4
Battery	3	Camera	1
Battery	4	Display	1
Display	1	Camera	5

6. Finally, calculations are made to see how each alternative contributes to the goal of the study, given in Table 8.

Table 8. Calculations for the alternatives with respect to criteria

Criterion	Priority vs Goal	Alternative	A	B	A×B
Price	0.080	A B C	0.656 0.265 0.080	0.080 0.080 0.080	0.052 0.021 0.006
Battery	0.456	A B C	0.557 0.123 0.320	0.456 0.456 0.456	0.254 0.056 0.146
Camera	0.318	A B C	0.620 0.156 0.224	0.318 0.318 0.318	0.197 0.050 0.071
Display	0.145	A B C	0.619 0.284 0.096	0.145 0.145 0.145	0.090 0.041 0.014

7. Final decision is made based on the overall priority for each alternative, given in Table 9.

Table. 9 Overall Priorities for all alternatives

	Priority with respect to				
Alternative	*Price*	*Battery*	*Camera*	*Display*	*Goal*
A	0.052	0.254	0.197	0.090	0.593
B	0.021	0.056	0.050	0.041	0.168
C	0.006	0.146	0.071	0.014	0.237
Totals	0.80	0.456	0.318	0.145	1.000

V. Results

The final results of the study are as follows: A is by far the best smartphone to be bought according to the selection criteria with a priority equal to 0.593. C is the second phone in the priority list with a value of 0.237. The results show that B is the last option between the three phones with a priority value equal to 0.168.

VI. Discussion

The study resulted in prioritizing the A phone over the other two phones under study. The AHP model was very helpful in determining the best phone as it gave weights to each alternative with respect to criteria, and for each criterion with respect to goal. It might be difficult to make a correct decision without applying a scientific method like the AHP. Some people might argue that the pairwise comparisons were biased, but the values were given based on multiple users' reviews.

VII. Conclusion

Individuals and organizations make decisions on a daily basis. Some people make the decision in minutes based on instinct. However, other people analyze the alternatives and selection criteria carefully. This paper followed the AHP model step by step to show a scientific way of making decisions. The results of the study made the decision making process easier, as it showed the difference between the candidates under study. Such a tool might be very helpful in other life situation, or more importantly in strategic decisions

made by organizations. The technique is logical as it translates the way people should think when making a decision into a mathematical model that gives numerical values for each alternative to make the selection process easier.

REFERENCES

[1] T. L. Saaty, "A scaling method for priorities in hierarchical structures," Journal of Mathematical Psychology, Vol. 15, No. 3, 1977 pp. 234-281.

[2] A. Ishizaka and A. Labib, "Analytic Hierarchy Process and Expert Choice: Benefits and limitations," OR Insights, Vol. 22, No. 4, 2009, pp. 201-220.

[3] O. Bayazit and B. Karpak, "An AHP application in vendor selection," The International Symposium on the Analytic Hierarchy Process (ISAHP) Honolulu, Hawaii, July 8-10, 2005.

[4] S. Alidi, "Use of the analytic hierarchy process to measure the initial viability of industrial projects," International Journal of Project Management, Vol. 14, No. 4, 1996, pp. 205-208.

[5] J. Azis, "Analysis Hierarchy Process in the benefit-cost framework: A post-evaluation of the Trans-Sumatra Highway Project," Eorepean Journal of Operational Research, Vol 48, No. 1, 1990, pp. 37-48.

[6] D. Garakhani and J. Mehrabi, "Sport marketing outsourcing using SWOT and AHP models," WALIA Journal, Special Issue 1, 2015, pp. 167-171.

[7] T. L. Saaty, Principia Mathematica Decernendi: Mathematical Principles of Decision Making, RWS Publications, 2009.

[8] T. L. Saaty, "Decision making with the analytic hierarchy process," International Journal of Services Sciences, Vol. 1, No. 1, 2008, pp. 83-98.

[9] S. Konz and S. Johnson, Work Design: Occupational Ergonomics, 7th Edition, Holcomb Hathaway Publishers, 2008.

[10] D. Shinder, "Smartphone selection criteria: What factors matter most to you?" TechRepublic, October 8, 2010. Available: http://www.techrepublic.com/blog/smartphones/smartphone-selection-criteria-what-factors-matter-most-to-you/

Suat Kasap have degrees in electrical-electronics engineering and industrial engineering. He received his Ph.D. in Industrial Engineering from the University of Oklahoma. His research interests are in human factors and ergonomics, occupational safety and health, work and process analysis, technology and innovation management, multi-criteria decision making, financial engineering, data mining, and modeling, analysis, and optimization of complex engineering problems. He has published in Journal of Global Optimization, Simulation, International Journal of Applied Logistics, Topics in Health Information Management, Journal of History Culture and Art Research. He also authored five book chapters in Green Finance and Sustainability: Environmentally – Aware Business Models and Technologies, Development and Implementation of RFID Technology, Handbook of Applied Optimization, Encyclopedia of Optimization, Volume IV, Handbook of Combinatorial Optimization. He worked in four different Industrial Engineering Departments of the American University of Middle East, University of Turkish Aeronautics Association, Hacettepe University, and Çankaya University as an assistant professor. He has taught courses on Work Analysis and Design, Ergonomic Work Analysis, Cognitive Ergonomics Work Analysis, Technology and Innovation Management, Management of Information Systems, Introduction to Optimization and Modeling, Deterministic Models of Operation Research, Project Management, Multi-criteria Decision Making.

Abdullah Atyani is a fresh industrial engineering graduate. He obtained his bachelor degree from the American University of the Middle East in Kuwait in 2016. During his college years, Abdullah has completed tens of real life projects related to his major in supply chains and logistics, operation research, simulation, ergonomics, quality control, etc. unfortunately, none of these projects was published. Talking about achievements, Abdullah was ranked first on his graduation year with a CGPA of 3.8. He participated in international engineering competitions like the annual IISE/ Arena Student Simulation competition and Microsoft Imagine Cup competition. Abdullah is seeking a professional academic career. He is planning to obtain his Master's degree and PhD in the upcoming years.