OPERATING SYSTEM SELECTION USING AHP ON THE BASIS OF SECURITY, PERFORMANCE AND COST

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Abstract - When we are thinking about choosing best Operating System for any specific requirement, then this selection is dependent on multiple parameters and criteria. In this paper, we apply "Analytical Hierarchy Process" (AHP) to investigate the performance of different Operating Systems for different criteria and select the most appropriate operating system. AHP is the Multi-Criteria Decision Making (MCDM) tool which is used in decision making. This paper shows the performance of Mac, Linux and Windows Operating Systems and selection of most suitable operating system among these according to the user's requirement.

Keywords - AHP, Operating System, MCDM, Criteria, Mac, Linux, Windows.

I. INTRODUCTION

Technology is developing at an incredible speed. With the acceleration of the development in the field of technology, it becomes necessary to take decisions more frequently for the update of the technology. Operating system is system software responsible for the direct control and management of the hardware, basic system operations and operating the programs of application. It provides the links to the memory, input/output devices and file system. If more than one program are operating simultaneously, the operating system is responsible for reserving enough sources for each of them in the system and preventing overlapping among these programs(Ball et al., 2009). So, selecting the most appropriate operating system according to user's requirement is not easy. This means Decision making on the basis of several criteria and alternatives is very

difficult task. To solve such problems we are using Analytical hierarchy process (AHP). AHP is the Multi-Criteria Decision Making (MCDM) tool that has been used in decision making. Multi-criteria decision making refers to find the best opinion from all of the feasible alternatives in the presence of multiple, usually conflicting, decision criteria (Isklar and Buyukozkan, 2007).

AHP is a multi criteria decision-making technique that allows the consideration of both objective and subjective factors in selecting the best alternative. AHP is based on three principles: decomposition, comparative judgment, and synthesis of priorities. The decomposition principle requires that the decision problem be decomposed into a hierarchy that captures the essential elements of the problem. The principle of comparative judgment requires assessment of pair wise comparisons of the elements within a given level of the hierarchical structure, with respect to their parent in the next-higher level. The synthesis principle takes each of the derived ratio-scale local priorities in the various levels of the hierarchy and constructs a composite (global) set of priorities for the elements at the lowest level of the hierarchy (i.e., alternatives) (Eldrandaly et al., 2003).Present study uses the Analytic Hierarchy Process (AHP) for the selection of the most suitable operating system according to the user's requirements.

II.OPERATING SYSTEM AND CRITERIA FOR SELECTION

A. Operating system

An operating system acts as an intermediary between the user of a computer and the computer hardware. The purpose of an operating system is to provide an environment in which a user can execute programs in a convenient and efficient manner (Silberschatz et al., 2004). Operating systems we are examining in this study are:

1) Windows: The most popular operating system now a day in all over the world. The operating system comes in very different format like single user, multi-user, network operating system etc. Windows was developed by Microsoft Corporation in 1980s. Windows XP was the most popular and widely using operating system till date, because of user-friendliness and easy to operate the

operating system still use by most of the people in the word. The latest version of Windows in market is Windows 8 launched commercially in Oct 2012 (Mudiraj, 2013).

2) Linux: Linux is free open source operating system allowing the free distribution and licensed by GNU (General Public license. Linux is the first multitasking and platform portable operating system. The main benefit of the Linux operating system is its free to use and its open source operating system which make it user level modifying operating system which make more user oriented than windows operating system. The Linux also provide the inbuilt utilities like system drivers, antivirus, reliability feature which make them more nonstop works on the client server environment without having reboot of the system. Now days the Linux operating system used as one of the most secure and anti threats operating system which is the one of the best protection mechanism providing operating system (Mudiraj, 2013).

3) Mac: Mac operating system was developed by the apple in 1984by the Apple Inc. Macintosh OSs was strictly GUI environments, with no command-line option. Mac OS X, with its UNIX origins, gives you the option of a character-based interface Apple Computers is the only manufacturer of Macintosh computers. Mac Operating system is Hardware oriented which has its own keyboard and mouse, where mouse is only has one button as left and right click button like normal mouse use in other operating system. As compare to the other operating systems the MAC operating system is expensive because it's not only OS but also it's an entire(Specific) system expected to purchase by the consumer torun the MAC operating system (Mudiraj, 2013).

B. Criteria for selecting operating system

We will consider different criteria or factors for selecting the operating system. They are:

1) Security: Computer resources must be guarded against unauthorized access, malicious destruction or alteration, and accidental introduction of inconsistency (Ball et al., 2009). So, privacy or security of data is important.

2) Performance: Performance of the operating system is a measure of the rate at which a system is capable of doing useful work (Randell). Performance of operating system is also important.

3) *Cost:* According to user point of view, they want that they get maximum facilities and features at affordable cost, so it is key factor of operating system.

III. THE ANALYTICAL HIERARCHY PROCESS (AHP)

The AHP provides a means of decomposing the problem into a hierarchy of sub problems which can more easily be comprehended and subjectively evaluated. The subjective evaluations are converted into numerical values and processed to rank each alternative on a numerical scale (Bhushan and Rai, 2004). The methodology of the AHP can be explained in following steps:

Step 1: The problem is decomposed into a hierarchy of goal, criteria, sub-criteria and alternatives. This is the most creative and important part of decision-making. Structuring the decision problem as a hierarchy is fundamental to the process of the AHP. Hierarchy indicates a relationship between elements of one level with those of the level immediately below. This relationship percolates down to the lowest levels of the hierarchy and in this manner every element is connected to every other one, at least in an indirect manner. Figure 1 shows a generic hierarchy structure. At the root of the hierarchy is the goal or objective of the problem being studied and analyzed. The leaf nodes are the alternatives to be compared. In between these two levels are various criteria and sub-criteria. It is important to note that when comparing elements at each level a decision-maker has just to compare with respect to the contribution of the lower-level elements to the upper-level one. This local concentration of the decision-maker on only part of the whole problem is a powerful feature of the AHP (Bhushan and Rai, 2004).
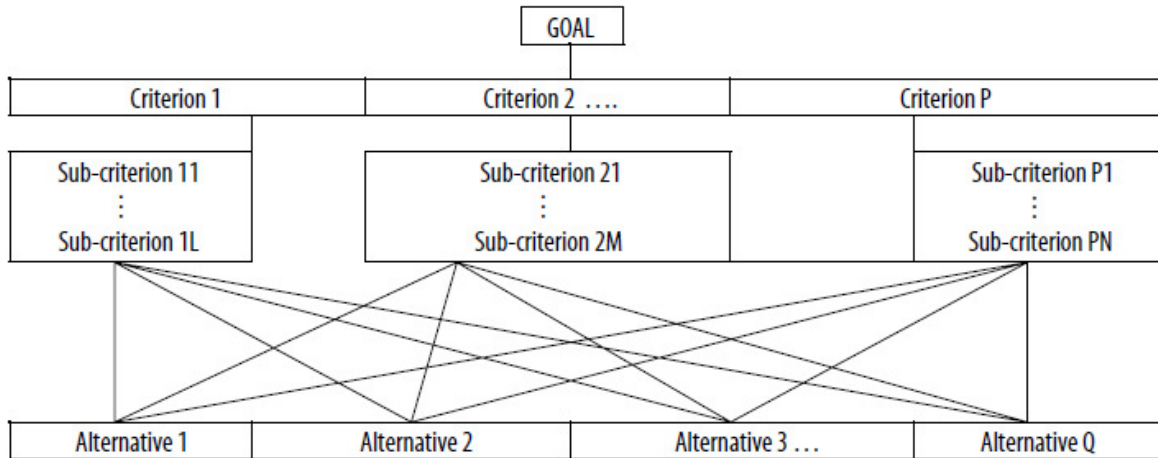
Figure 1. Generic hierarchic structure.

Step 2: Data are collected from experts or decision-makers corresponding to the hierarchic structure, in the pair wise comparison of alternatives on a qualitative scale as described below. Experts can rate the comparison as equal, marginally strong, strong, very strong, and extremely strong (Bhushan and Rai, 2004).The opinion can be collected in a specially designed format as shown in Figure 2.
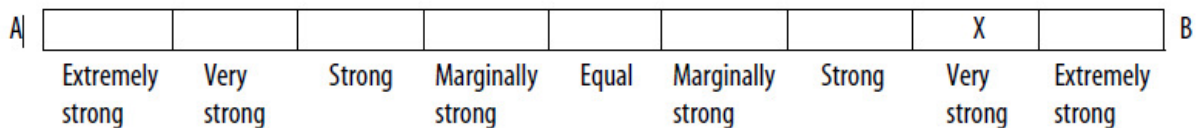

Figure 2. Format for pair wise comparisons.

"X" in the column marked "Very strong" indicates that B is very strong compared with A in terms of the criterion on which the comparison is being made (Bhushan and Rai, 2004). The comparisons are made for each criterion and converted into quantitative numbers as per Table 1.

Table 1.Gradation scale for quantitative comparison of alternatives.

Option	*Numerical value(s)*
Equal	1
Marginally strong	3
Strong	5
Very strong	7
Extremely strong	9
Intermediate values between the two adjacent judgments	2,4,6,8
Reflecting dominance of second alternative compared with the first	Reciprocals

Step 3: The pairwise comparisons of various criteria generated at step 2 are organized into a square matrix. The diagonal elements of the matrix are 1. The criterion in the *i*th row is better than criterion in the *j*th column if the value of element(i, j) is more than 1; otherwise the criterion in the *j*th column is better than that in the *i*th row. The (j, i) element of the matrix is the reciprocal of the (i, j) element (Bhushan and Rai, 2004).

Step 4: The principal eigen value and the corresponding normalized right eigen vector of the comparison matrix give the relative importance of the various criteria being compared. The elements of the normalized eigenvector are termed weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives (Bhushan and Rai, 2004).

Step 5: The consistency of the matrix of order *n* is evaluated. Comparisons made by this method are subjective and the AHP tolerates inconsistency through the amount of redundancy in the approach. If this consistency index fails to reach are required level then answers to comparisons

may be re-examined. Saaty suggests the value of Consistency Ratio should be less than 0.1 (Bhushan and Rai, 2004).

Step 6: The rating of each alternative is multiplied by the weights of the sub-criteria and aggregated to get local ratings with respect to each criterion. The local ratings are then multiplied by the weights of the criteria and aggregated to get global ratings (Bhushan and Rai, 2004).

The AHP produces weight values for each alternative based on the judged importance of one alternative over another with respect to a common criterion. The alternative with highest weight value or eigen value or priority will be chosen.

VI. ANALYSIS OF DIFFERENT OPERATING SYSTEMS USING AHP

In this study we have three alternatives i.e. operating system, we have to select only one operating system according to requirements of user, this is difficult task. Operating systems are- Linux, Mac and Windows and factors are- security, speed and cost. By using AHP, we choose the best operating system according to user requirements. Fig. 3 shows the hierarchical tree for our alternatives.
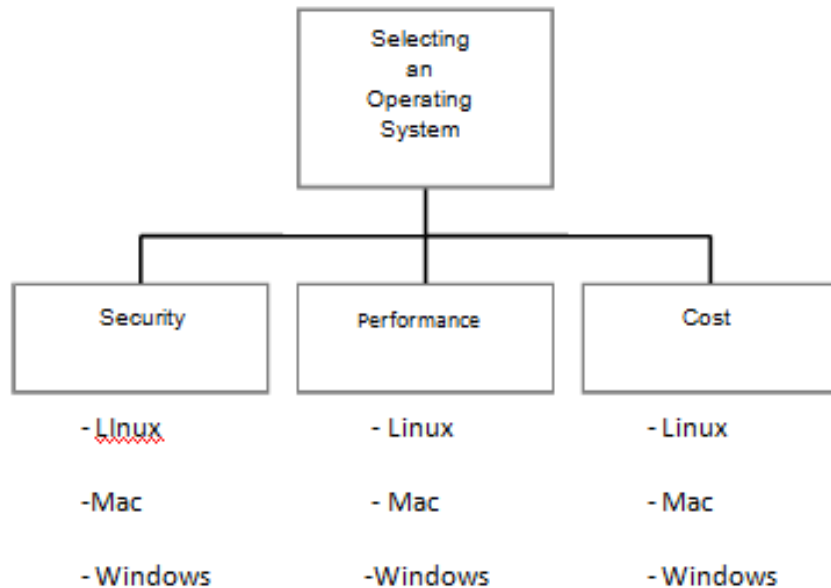
Figure 3. Hierarchy structure

Pairwise comparison and ranking of criteria:

In pair wise comparisons, alternatives are compared in pairs. Let us make a relative scale to measure how much you like the factor/ operating system on the left compared to the factor or operating system on the right. We need to compare the factors with respect to their importance in reaching the goal. Fig. 4 shows the relative scales comparing the factors. This figure shows that importance of security is three times as compared to performance, importance of performance is three times as compared to cost and importance of security is five times as compared to cost.
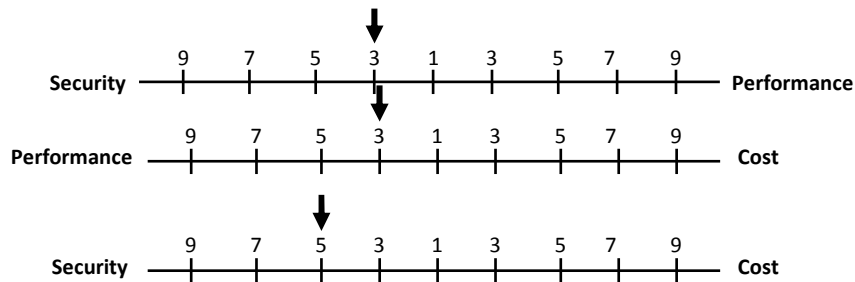
Figure. 4 Relative Scale comparing factors

After that we make the matrix according to two conditions that are give below:-

1. We put the actual judgment value, if the judgment value is on the left side of 1.

2. We put the reciprocal value, if the judgment value is on the right side of 1.

Comparison Matrix is made between different criteria (Security, Performance, Cost) and priority vector /weights are also calculated as shown below-

Criteria	Security	Performance	Cost		Priority Vector
Security	1	3	5		0.6334
Performance	1/3	1	3	=	0.2605
Cost	1/5	1/3	1		0.1061

Following the same procedure comparison matrix between different alternatives according to criteria will be made. Security in Linux OS is higher than Mac and security in Mac is higher than

windows. Comparison Matrix between different Operating system (Linux, Mac, Windows) according to security and priority/ eigen vector is-

Security	Linux	Mac	Window		Priority Vector
Linux	1	3	7		0.6687
Mac	1/3	1	3	=	0.2431
Windows	1/7	1/3	1		0.0882

Performance of Mac is better than Linux and performance of Linux is better than windows. Comparison Matrix between different Operating system (Linux, Mac, Windows) according to performance and priority/ eigen vector is-

Performance	Linux	Mac	Window		Priority Vector
Linux	1	1/3	3		0.2605
Mac	3	1	5	=	0.6334
Windows	1/3	1/5	1		0.1061

Linux is free. Cost of Mac OS is higher than Windows. Comparison Matrix between different Operating system (Linux, Mac, Windows) according to cost and priority/ eigen vector is-

Cost	Linux	Mac	Window		Priority Vector
Linux	1	9	5		0.7481
Mac	1/9	1	1/3	=	0.0714
Windows	1/5	3	1		0.1804

Final priorities: After getting the priorities of the alternatives with respect to the criteria, the priorities of the Criteria with respect to the Goal, and we can calculate the priorities of the alternatives with respect to the Goal. This is calculated by multiplying.

	Security	Performance	Cost		Priority Vector for criteria		Alternatives	Weights/ Eigen Vector
Linux	0.6687	0.2605	0.7481		0.6334		Linux	0.5709
Mac	0.2431	0.6334	0.0714	=	0.2605	=	Mac	0.3266
Windows	0.0882	0.1061	0.1804		0.1061		Windows	0.1026

V. CONCLUSION

AHP technique is applied on the given information in pair wise comparison matrix for the criteria and the pair wise comparison matrix for the alternatives on the basis of these criteria, and finally we have got the final scores for all three alternatives.

Score of Linux Operating System: 0.5709

Score of Mac Operating system: 0.3266

Score of Windows Operating System: 0.1026

After applying AHP methods, Linux operating system has the highest priority/weight/score, which shows that Linux is the most suitable Operating System for the user. Linux operating

system will be selected according to these user requirements, because it is more secure and cost free. Hence we can safely conclude that AHP can be used for the selection of Operating systems.

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