



Operating System Selection using AHP on the basis of Security, Cost and Boot Time

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Abstract- Selection of best Operating System for any specific requirement is dependent on multiple parameters and criteria. In this paper, we are going to apply “Analytic Hierarchy Process” (AHP) to evaluate the performance of different operating System and to select the best operating system. AHP is a Multi-Criteria Decision Making (MCDM) tool developed in the 1970s by Thomas Saaty which is used in decision making. This paper presents the comparative performance analysis of Linux, Mac and Windows operating systems and selection of best operating system according to different criteria. Criteria or parameters taken for selection of best operating system are security, cost and boot time.

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

I. INTRODUCTION

Human lives are the sum of their decisions-whether in business or in personal spheres. In daily lives, people often have to make decisions [1]. An operating system is a set of programs that manage computer hardware resources and provide common services for application software. The operating system is the most important type of system software in a computer system [2]. 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. We can define a generic decision-making problem as consisting of the following activities [3]:

- Studying the situation.
- Organizing multiple criteria.
- Assessing multiple criteria.
- Evaluating alternatives on the basis of the assessed criteria.
- Ranking the alternatives.
- Incorporating the judgements of multiple experts.

The theory of decision analysis is designed to help the individual make a choice among a set of pre-specified alternatives. The decision making process relies on information about the alternatives. In the multi criteria decision-making (MCDM) context, the selection is facilitated by evaluating each choice on the set of criteria. [4]. Multi-criteria decision making (MCDM) refers to find the best opinion from all of the feasible alternatives in the presence of multiple, usually conflicting, decision criteria. AHP technique investigated in the present study is a multi-criteria decision making technique developed by Saaty [5]. AHP is one of the best ways for deciding among the complex criteria structure in different levels [1].

The AHP is a decision support tool which can be used to solve complex decision problems. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives. The pertinent data are derived by using a set of pairwise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion. If the comparisons are not perfectly consistent, then it provides a mechanism for improving consistency [6].

AHP helps decision-makers choose the best solution from several options and selection criteria [7].

II. RELATED WORK

Triantaphyllou et al. (1995) presented a paper and examined some of the practical and computational issues involved when the AHP method is used in engineering applications and they conclude that the AHP provides a convenient approach for solving complex MCDM problems in engineering. Alexander (2012) presented a paper in which they showed SAS/IML can be used to implement the Analytic Hierarchy Process (AHP). His presentation was about one of the most famous methods for making multi-criteria decisions called the Analytic Hierarchy Process or AHP. He showed how SAS/IML implements AHP to help decision makers choose the best solution among several alternatives across multiple criteria.

Fui et al. described the successful adoption of AHP for the evaluation of several large-scale government tenders as well as the enhanced AHP methodology developed within the defense community for evaluating complex systems. In their

study, they showed the use of AHP for evaluation had proved to be successful despite the varied nature of government projects. The criteria used for these projects are generally not mission-oriented and are relatively independent of one another, making AHP an ideal tool.

Bhushan et al. (2004), described a Formal Decision-Making Framework- “The Analytic Hierarchy Process”, The AHP has proved a theoretically sound and market tested and accepted methodology. Its almost universal adoption as a new paradigm for decision-making coupled with its ease of implementation and understanding constitute its success. More than that, it has proved to be a methodology capable of producing results that agree with perceptions and expectations.

III. OPERATING SYSTEM AND CRITERIA FOR SELECTION

A. Operating system

Operating system is an interface between user and hardware. An operating system can be defined to be that part of a computer system which attempts to so allocate and co-ordinate the resources of the system to achieve the optimum performance of that system. The resources involved include processors, peripheral I/O devices, operating system facilities, memory and time. The task is further complicated by the fact the operating system itself must use these resources [8]. 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 is 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 [9].

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. 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 [9].

3) Mac: Mac operating system was developed by the apple in 1984 by the Apple Inc. 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 to run the MAC operating system.

B. Criteria for selecting operating system

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

1) Security: Security is keeping unauthorized entities from doing things you don’t want them to do. Computer resources must be guarded against unauthorized access, malicious destruction or alteration, and accidental introduction of inconsistency [5]. So, privacy or security of data is important.

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

3) Boot time: Boot time is the time the computer takes while doing a set of operations when the electric power is switched on and continues until it is ready to use.

IV. THE ANALYTIC HIERARCHY PROCESS

AHP is a decision making support tool developed in the 1970s by Thomas Saaty, a mathematics lecturer from the University of Pittsburgh, US. AHP steps are:

1) The process requires the establishment of a hierarchy of criteria which is important to achieve the goal of the decision problem [10].

2) Weights denoting the relative level of importance are assigned to each criterion using pairwise comparison—a method which compares two criteria that are on the same level to determine their relative importance. The comparison is done based on a simple ratio scale of one to nine as defined in Table 1 [10].

Table 1 Saaty’s scale for pairwise comparison

Definition	Intensity
Equal importance/quality	1
Moderately more important/ better	3
Strongly more important / better	5
Very strongly more important / better	7
Extremely more important / better	9
Intermediate values	2,4,6,8

3) The pairwise comparisons of various criteria generated at step 2 are organised into a square matrix. The diagonal elements of the matrix are 1. How to fill up the upper triangular matrix is using the following rules:

- If the judgment value is on the left side of 1, we put the actual judgment value.

- If the judgment value is on the right side of 1, we put the reciprocal value.
- 4) The principal eigenvalue and the corresponding normalised right eigenvector of the comparison matrix give the relative importance of the various criteria being compared. The elements of the normalised eigenvector are termed weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives [3].
- 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 a required level then answers to comparisons may be re-examined. The consistency index, CI, is calculated as

$$CI = (\lambda_{\max} - n)/(n - 1)$$

Where, λ_{\max} Principal Eigen value is obtained from the summation of products between each element of Eigen vector and the sum of columns of the reciprocal matrix. This CI can be compared with that of a random Index, RI.

Table 2 Random Index (RI)

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

Consistency Ratio (CR), which is a comparison between Consistency Index (CI) and Random Consistency Index (RI).

$$CR = CI/RI$$

Saaty suggests the value of CR should be less than 0.1.

- 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.

V. APPLYING AHP FOR OPERATING SYSTEM SELECTION

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, cost and Boot Time. By using AHP, we choose the best operating system according to user requirements. Fig. 1 shows the hierarchical tree for our alternatives.

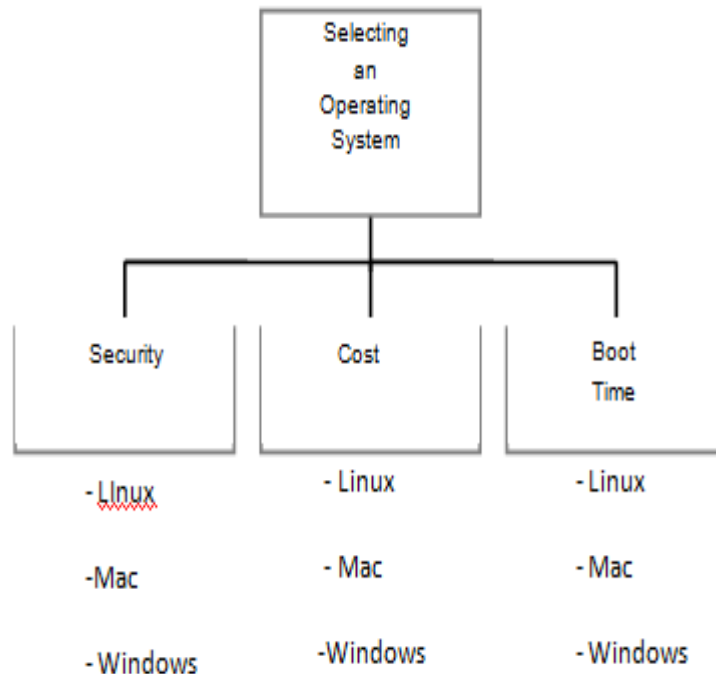


Figure 1 Hierarchical structure

Now, 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. 2 shows the relative scales comparing the factors considered in our study.

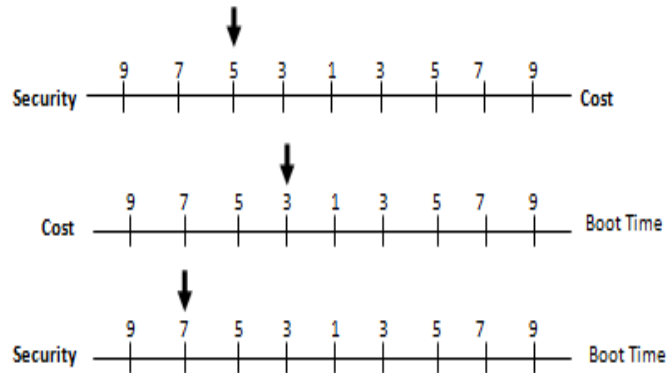


Figure 2 Relative Scale comparing factors

After that we make the matrix according to the conditions mentioned above. Comparison Matrix is made between different criteria as shown in table 3. Then the priority or eigen vector /weights are also calculated and Consistency is also checked. The value of CR should be less than 0.1 , otherwise the whole matrix has to be re-examined.

Table 3 AHP for Criteria

	Security	Cost	Boot-time	Priority
Security	1	5	7	0.7235
Cost	1/5	1	3	0.1932
Boot-time	1/7	1/3	1	0.0833

$\lambda_{max} = 3.1115$, CI= 0.0558, CR=0.0962

For this comparison matrix CR=0.0962, which is less than 0.1. Means in this matrix inconsistency is less than 10%, which is acceptable.

Following the same procedure comparison matrix between different alternatives according to criteria will be made. Comparison Matrix between different Operating system (Linux, Mac, Windows) according to security, cost and Boot time are shown and priority/ eigen vector and CR are also shown in table 4, table 5, table 6 –

Table 4 AHP for Security

	Linux	Mac	Windows	Priority
Linux	1	3	7	0.6687
Mac	1/3	1	3	0.2431
Windows	1/7	1/3	1	0.0882

$\lambda_{max} = 3.0107$, CI= 0.0054, CR=0.0092

Table 5 AHP for Cost

	Linux	Mac	Windows	Priority
Linux	1	9	5	0.7482
Mac	1/9	1	1/3	0.0714
Windows	1/5	3	1	0.1804

$\lambda_{max} = 3.0517$, CI= 0.0259, CR=0.0447

Table 6 AHP for Boot Time

	Linux	Mac	Windows	Priority
Linux	1	1/7	1/5	0.0738
Mac	7	1	3	0.6434
Windows	5	1/3	1	0.2828

$\lambda_{max} = 3.097$, CI= 0.0485, CR=0.0836

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 the matrices or priority vectors.

$$\begin{bmatrix} 0.6687 & 0.7482 & 0.0738 \\ 0.2431 & 0.0714 & 0.6434 \\ 0.0882 & 0.1804 & 0.2828 \end{bmatrix} \begin{bmatrix} 0.7235 \\ 0.1932 \\ 0.0833 \end{bmatrix}$$

Here the first matrix is made from priority vectors of alternatives w.r.t. each criteria i.e. Columns in this matrix are Priority vectors from AHP for security, cost and boot time. Second matrix is the priority vector calculated from comparison matrix of criteria i.e. from AHP for Criteria. After multiplication, the Priority vector is:

Alternatives	Priority Vector
Linux	0.6345
Mac	0.2433
Windows	0.1223

VI. CONCLUSION

AHP technique is applied for selecting the best operating system between Linux, Mac and Windows according to Security, Cost and Boot time and finally we have got the final scores for all three alternatives,

Score of Linux Operating System: 0.6345

Score of Mac Operating system: 0.2433

Score of Windows Operating System: 0.1223

So, we can conclude that Linux is best operating System for any user if high security, less cost is required. But the booting time for Linux is more than other OS. As we have given the least preference to boot time and highest preference to security.

For this reason, Linux is the best operating system because it is secure and also it is open source operating system. Hence we can conclude that AHP can be used for the selection of Operating systems.

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