Choosing the Best Anti-Virus in the World by Application of TOPSIS Method

Hesam Naie [1], Kaveh Teymournejad [2]

[1.] Department of Executive Management, Faculty of Management and Accounting, Islamic Azad University (IAU), Qazvin Branch, Qazvin, Iran. E-mail: Hesam.naie@yahoo.com
[2.] Assistant Professor, Department of Public Administration, Faculty of Management, Islamic Azad University (IAU), Central Tehran Branch, Tehran, Iran. E-mail: Info@dr-teymournejad.com

Abstract: Decision making problem is the process of finding the best option from all of the feasible alternatives. Due to the fact that, the collected data for choosing an anti-virus isn't concrete and substantial the way users demand including the risk attitude for a decision maker which is somehow unknown, and considering the increase in the complexity and the variety of decision making problems, the methods of decision making become more varied and will have more capability of problem solving. We present a new TOPSIS method for normalizing the collected data and ranking the alternatives, a multi-attribute decision making (MADM) technique for ranking and selection of a number of externally determined alternatives through distance measures. A Technique for Order Preference by Similarity to Ideal Solution method is a multiple criteria method to identify solution from finite set of points and by eliminating the units of criterion functions and determining a solution with the shortest distance to the ideal solution and the greatest distance from the negative-ideal one. For this research some of these criteria considered are "Detection and Missed Samples", "False Positive/Alarm", "Scanning Speed", "Encoding and transcoding" and so on.
[Hesam Naie, Kaveh Teymournejad. **Choosing the Best Anti-Virus in the World by Application of TOPSIS Method.** *Life Sci J* 2012.9(4):5082-5090] (ISSN: 1097-8135). http://www.lifesciencesite.com. 758

Keywords: MCDM, TOPSIS Method, Antivirus, Criteria of Anti-Viruses

1. Introduction

The Anti-Virus (Post and Kagan, 1998) secures the computers by observing and reviewing files contents (Post and Kievit, 1991). If it observes viruses prevents them from entering into your computer and/or executing, by giving you a warning and asking you for command of deletion and taking your precautionary measures. But one of the foremost concerns for those, who work with computer, is to select and install a safe and secure anti-virus for protection of their computers. Computer viruses are developed every day and to prevent them to ruin the existing files seems to be inevitable. Therefore, the applications of anti-viruses are growing more than ever. However, if you observe the anti-viruses market, you will be certainly shocked by seeing a large numbers of anti-viruses brands, consequently this may cause the problem for selecting a suitable anti-viruses. The fact is every one considers certain criteria to select safe anti-virus. Therefore, we should notice this important point that there is no perfect anti-virus and that we should always keep checking and testing the installed security software on our systems.

Computer viruses have been extensively studied by many authors (Cohen, 1990). In 1984, Fredrick B. Cohen (Cohen, 1987) purposed term Computer Virus. Computer viruses are those programs, which are spread like biologic viruses and execute unexpected measures when they enter into computers. Despite the fact that all viruses are not dangerous, most of them have been written with the aim of destruction of certain types of files, application programs and/or operating systems. Like all other programs, viruses are benefited from system sources such as memory and hard disk space, CPU power and other sources. They can do dangerous actions, for instance, they may damage the computer systems erasing data, stealing information or modifying the normal operation (Jose et al., 2008). Also, a virus may provide license of access to the device via network or without identification.

The functions of existing anti-virus are not the same. Such anti-virus covers the files and/or its memory in order to review the existing certain virus signatures, which may contaminate the system. Anti-viruses are seeking for the virus signatures based on certain signs, definitions and/or identified of viruses. The computer viruses programmer always writes new computer viruses and updates their former written ones. Therefore, it always requires updating the information bank including definitions and computer virus signatures relating to the given software. After installation of the anti-virus on your computer, you may do scan and review the system in order to identify the existing virus at certain time intervals or period (Naie et al., 2011).

Performance of anti-viruses is also reviewed based on criteria and by using TOPSIS method where these criteria are main parameters for comparison and evaluation of anti-viruses against types of viruses and internet worms as well as spywares and malwares.

Multiple criteria decision making (MCDM) is the tool most frequently used to deal with conflict management (Fu et al., 2007; Shi et al., 2005). Practical problems are often characterized by several non-commensurable and conflicting (competing) criteria, and there may be no solution satisfying all criteria simultaneously. Therefore, the solution is a set of non-inferior solutions, or a compromise solution according to the decision makers' preference. A compromise solution for a problem with conflict criteria can allow the decision makers to reach a final decision. The foundation for compromise solutions was established by Yu (1973) and Zeleny (1982), and other distance-based techniques have also been developed (Chen and Hwang, 1992).The compromise solution is a feasible solution closest to the ideal/aspired level and a compromise means an agreement established by mutual concessions.

The TOPSIS (technique for order performance by similarity to ideal solution) was first developed by Hwang & Yoon (1981). According to this technique, the best alternative would be the one that is nearest to the positive-ideal solution and farthest from the negative ideal solution (Ertugrul & Karakasoglu, 2007). The positive- ideal solution is a solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang & Elhag, 2006). In short, the positive-ideal solution is composed of all best values attainable from the criteria, whereas the negative ideal solution consists of all worst values attainable from the criteria (Wang, 2007). Interested readers can check the contents of Shih et al. (2007) for more details of TOPSIS and There have been lots of studies in the literature using TOPSIS for the solution of MCDM problems. (Chen, 2000; Chu, 2002; Chu & Lin, 2002; Lai, Liu, & Hwang, 1994; Wang et al., 2005).

In this article, we have tried to select the best anti-viruses from 20 globally introduced anti-viruses by using TOPSIS method. The existing lists comprise names of anti-viruses in alphabetic order (On-Demand Comparative; 2011, Performance Test, 2011).

The used test-set contain about 200 thousands recent/prevalent malware sample from last months and consists of: (On-Demand Comparative, 2011).

Similarly, this review has been conducted on a computer with the following specifications (On-Demand Comparative, 2011).

- WINDOWS : Windows XP service pack 3
- CPU : Intel Core 2 Duo E8300/2.83 GHz
- RAM : 2 GB Ram
- HARD DISK : SATA II

Table 1: 20 globally introduced anti-virus software

Anti-Virus	Version
Avast! Free Antivirus 6.0	6.0.1203
AVG Anti-Virus 2012	10.0.1392
AVIRA Free Antivirus 2012	10.2.0.700
Bitdefender Antivirus Plus 2012	15.0.27.319
eScan Anti-Virus 11	11.0.1139.998
ESET NOD32 Antivirus 5	5.0.90.0
F-Secure Anti-Virus 2012	10.51.106
G DATA Antivirus 2012	22.0.2.32
K7 Antivirus Plus 11.1	11.1.0050
Kaspersky Anti-Virus 2012	12.0.0.374
McAfee Antivirus Plus 2012	15.0.291
Microsoft Security Essentials 2.1	2.1.1116.0
Panda Cloud Antivirus Free 1.5.1	1.5.1
PC Tools Spyware Doctor with Antivirus 2012	8.0.0.655
Qihoo 360 Antivirus 2.0	2.0.1.1332
Sophos Endpoint Security 9.7	9.7.4
Symantec Norton Antivirus 2012	19.1.0.21
Trend Micro Titanium Antivirus Plus 2012	2012
TrustPort Antivirus 2012	10.0.0.4796
Webroot Secure Anywhere Antivirus 2012	7.0.11.25

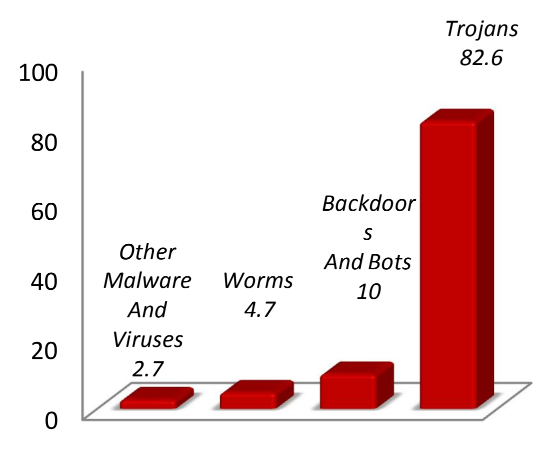

Figure 1. Diagram of computer destructive codes and anti-viruses

2. Method

Decision-making problem is the process of finding the best option from all of the feasible alternatives. In almost all such problems the multiplicity of criteria for judging the alternatives is pervasive. That is, for many such problems, the decision maker wants to solve a multiple criteria decision making (MCDM) problem. Multiple criteria decision making may be considered as a complex and dynamic process including one managerial level and one engineering level (Duckstein & Opricovic , 1980). The managerial level defines the goals, and chooses the final ''optimal'' alternative. The multi-criteria nature of decisions is emphasized at this managerial level, at which public officials called ''decision makers'' have the power to accept or reject the solution proposed by the engineering level. These decision makers, who provide the preference structure, are ''off line'' from the optimization procedure done at the engineering level. A MCDM problem can be concisely expressed in matrix format as

	C_1	C_2	...	C_n
A_1	x_{11}	x_{12}	...	x_{1n}
A_2	x_{21}	x_{22}	...	x_{2n}
A_m	x_{m1}	x_{m2}	...	x_{mn}

W= [w1 ; w2 ; . . . ; wn]

Where A1,A2, . . . ,Am are possible alternatives among which decision makers have to choose, C1,C2, . . . ,Cn are criteria with which alternative performance are measured, xij is the rating of alternative Ai with respect to criterion Cj, wj is the weight of criterion Cj. The main steps of multiple criteria decision making are the following:

(a) Establishing system evaluation criteria that relate system capabilities to goals.

(b) Developing alternative systems for attaining the goals (generating alternatives).

(c) Evaluating alternatives in terms of criteria (the values of the criterion functions).

(d) Applying a normative multi-criteria analysis method.

(e) Accepting one alternative as ''optimal'' (preferred).

(f) If the final solution is not accepted, gather new information and go into the next iteration of multi-criteria optimization.

Steps (a) and (e) are performed at the upper level, where decision makers have the central role, and the other steps are mostly engineering tasks. For step (d), a decision maker should express his/her preferences in terms of the relative importance of criteria, and one approach is to introduce criteria weights. This weights in MCDM do not have a clear economic significance, but their use provides the opportunity to model the actual aspects of decision making (the preference structure). In classical MCDM methods, the ratings and the weights of the criteria are known precisely (Fishburn et al.,1992). A survey of the methods has been presented Hwang and Yoon (1981). Technique for order performance by similarity to ideal solution (TOPSIS) (Lai et al., 1994), one of known classical MCDM method, was first developed by Hwang and Yoon (1981).

TOPSIS method is a technique for order preference by similarity to ideal solution that maximizes the benefit criteria/attributes and minimizes the cost criteria/attributes, whereas the negative ideal solution maximizes the cost criteria/attributes and minimizes the benefit criteria/attributes. The best alternative is the one, which is closest to the ideal solution and farthest from the negative ideal solution. Suppose a MCDM problem has n alternatives, A1,A2, . . . ,An, and m decision criteria/attributes, C1,C2, . . . ,Cm. Each alternative is evaluated with respect to the m criteria/attributes. Each value assigned to each alternative with respect to each criterion form a decision matrix denoted by X = (Xij)n×m as below :

$$\mathbf{X} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2m} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{im} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nj} & \cdots & x_{nm} \end{bmatrix}. \quad (1)$$

Let W = $(w_1, w_2, \ldots, w_m)$ be the relative weight vector about the criteria, satisfying $\sum_{j=1}^{m} w_j = 1$. Then the procedure of TOPSIS can be expressed in a series of steps:

Step 1. Calculate the normalized decision matrix. Some normalized methods for TOPSIS are summarized by Shih et al (2007).For simplify, a vector normalization method is introduced whose normalized value n_{ij} is calculated as:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{n} x_{kj}^2}} \quad i = 1,2,\ldots,n \quad j = 1,2,\ldots,m \qquad (2)$$

Step 2. Calculate the weighted normalized decision matrix V = $(v_{ij})_{n \times m}$:

$$v_{ij} = w_j n_{ij} \quad i = 1,2,\ldots,n \quad j = 1,2,\ldots,m \qquad (3)$$

Where w_j is the relative weight of the jth criterion/attribute, and $\sum_{j=1}^{m} w_j = 1$.

Step 3. Determine the positive ideal A^+ and negative ideal solution A^- as below

$$A^+ = \{ v_1^+, v_2^+, \ldots, v_m^+ \} = \{(max_i\, v_{ij} \mid j \in \Omega_b), (min_i\, v_{ij} \mid j \in \Omega_c)\} \qquad (4)$$

$$A^- = \{ v_1^-, v_2^-, \ldots, v_m^- \} = \{(min_i\, v_{ij} \mid j \in \Omega_b), (max_i\, v_{ij} \mid j \in \Omega_c)\} \qquad (5)$$

Where Ω_b is associated with benefit criteria, and Ω_c is associated with cost criteria.

Step 4. Calculate the separation measures, using the m-dimensional Euclidean distance. The separation of each alternative from the ideal solution (A^+) and the negative ideal solution (A^-) are given as below, respectively:

$$D_i^+ = \sqrt{\sum_{j=1}^{m}\left(v_{ij} - v_j^+\right)^2} \quad i = 1,2,\ldots,n \qquad (6)$$

$$D_i^- = \sqrt{\sum_{j=1}^{m}\left(v_{ij} - v_j^-\right)^2} \quad i = 1,2,\ldots,n \qquad (7)$$

Step 5. Calculate the relative closeness of each alternative to the ideal solution. The relative closeness of the alternative A_i with respect to A^+ is defined as:

$$RC_i = \frac{D_i^+}{D_i^+ + D_i^-} \qquad i = 1,2,\ldots,n \qquad (8)$$

Step 6. Rank the alternatives according to the relative closeness to the ideal solution. The smaller the value RC_i, the less distance the alternative A_i to the ideal solution. The best alternative is the one with the greatest relative closeness to the ideal solution.

3. Data Analysis

Performing data analysis can include various criteria. We have chosen these eight criteria, including, detection and missed samples, fast positive alarm, scanning speed, file copying, archiving and unarchiving, encoding and transcoding, installing and uninstalling applications, launching application. These eight are the most important ones (On-Demand Comparative; 2011, Performance Test, 2011).

3.1. Detection and Missed Samples

The following diagram shows anti-viruses situation in detection and cleaning of computer viruses. The used percentages in this diagram indicate number of undetected viruses among total employed destructive codes in this comprehensive evaluation. Thus, the lower level for each anti-virus shows the stronger performance of it (On-Demand Comparative, 2011).

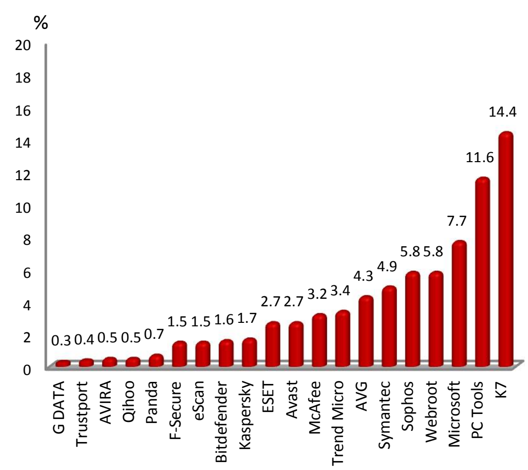

Figure 2. Diagram of number of undetected anti-viruses among all employed destructive codes in this assessment

3.2. False Positive/Alarm

In order to better evaluate the quality of the detection capabilities of anti-virus products (distinguish good files from malicious files), we provide also a false alarm test. False alarms can sometimes cause as much trouble as a real infection. Please consider the false alarm rate when looking at the detection rates, as a product, which is prone to cause false alarms, achieves higher scores easier (all discovered false alarms were reported/send to the respective Anti-Virus vendors and have been fixed). Number of false alarms found in our set of clean files (lower is better). The graph above shows the number of false alarms found in our set of clean files bye the tested anti-virus products. The graph below shows the number of false alarms found in our set of clean files by the tested Anti-Virus products (On-Demand Comparative. 2011).

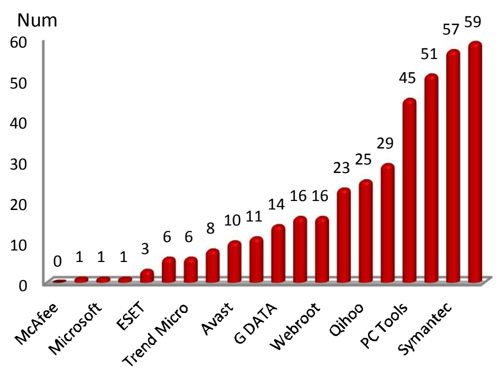

Figure 3. Diagram of codes error identification and safe files by anti-viruses

3.3. Scanning Speed

Anti-Viruses products have different scanning speeds due to various reasons. It has to be taken in account of how reliable the detection rate of an Anti-Virus is; if the Anti-Virus product uses code emulation, if it is able to detect difficult polymorphic viruses, if is does a deep heuristic scan analysis and active rootkit scan, how deep and thorough the unpacking and unarchiving support is, additional security scan, if it really scans all file types (or uses e.g. white lists in the cloud), etc.Most products have technologies to decrease scan times on subsequent scans by skipping previously scanned files. As we want to know the scan speed (when files are really scanned for malware) and not the skipping files sped, those technologies are not taken info account here, In our opinion some products should inform the users more clearly about the performance-optimized scans and then let the users decide if they prefer a short performance-optimized scan (which does not re-check all files, with the potential risk of overlooking infected files!) or a full-security scan.

The following graph shows the throughput rate in MB/Sec (higher is faster) of the various Anti-Virus products when scanning (on-demand) with highest setting our whole set of clean files (used for the false alarm testing). The scanning throughput rate will vary based on the set of clean files, the setting and the hardware used (On-Demand Comparative, 2011).

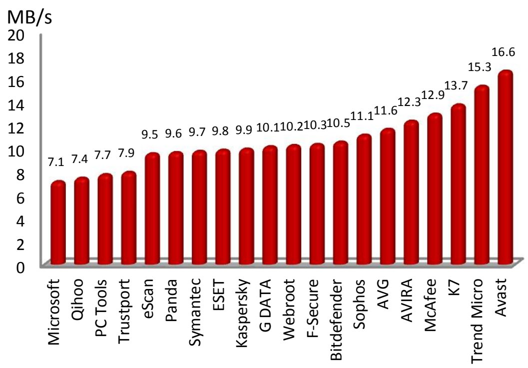

Figure 4. Diagram of anti-virus performance speed in detection and removal destructive codes

3.4. File Copying

Some Anti-Virus Products do not scan all kind of files by design/default (e.g. based on their file extensions), or use fingerprinting technologies, which may skip already scanned files in order to increase the speed. We copied a set of different file types which are wide-spread at home and office workstations from one physical hard disk to another physical hard disk (Performance Test, 2011).

Table 2. File coping speed from one physical hard disk to another physical hard disk

Anti-Virus	Score	Value
Avast	Very Fast	9
AVG	Very Fast	9
AVIRA	Very Fast	9
Bitdefender	Very Fast	9
eScan	Very Fast	9
ESET	Very Fast	9
F-Secure	Very Fast	9
G DATA	Very Fast	9
K7	Very Fast	9
Kaspersky	Very Fast	9
McAfee	Mediocre	5
Microsoft	Very Fast	9
Panda	Very Fast	9
PC Tools	Fast	7
Qihoo	Very Fast	9
Sophos	Very Fast	9
Symantec	Very Fast	9
Trend Micro	Fast	7
Trustport	Fast	7
Webroot	Very Fast	9

3.5 Archiving and Unarchiving

Archives are commonly used for file storage, and the impact of Anti-Virus software on the time taken to create new archives or to unarchive files from existing archives may be to interest for most users. We archived a set of different file types which are widespread at home and office workstations from one physical hard disk to another physical hard disk and unzipped them after this again on a third physical hard disk. The results already consider the fingerprinting/optimization technologies of the Anti-Virus product, as most users usually make archives of files they have on their disk (Performance Test, 2011).

Table 3. Archiving and unarchiving speed a set of different file types which are widespread

Anti-Virus	Score	Value
Avast	Very Fast	9
AVG	Very Fast	9
AVIRA	Very Fast	9
Bitdefender	Fast	7
eScan	Very Fast	9
ESET	Very Fast	9
F-Secure	Very Fast	9
G DATA	Fast	7
K7	Very Fast	9
Kaspersky	Very Fast	9
McAfee	Very Fast	9
Microsoft	Very Fast	9
Panda	Very Fast	9
PC Tools	Slow	3
Qihoo	Fast	7
Sophos	Very Fast	9
Symantec	Very Fast	9
Trend Micro	Fast	7
Trustport	Mediocre	5
Webroot	Very Fast	9

3.6. Encoding and Transcoding

Music files are often stored and converted on home systems, and converting such files takes system resources. Due that, many home users may be interested to know if their Anti-Virus product imposes a slowdown while converting multimedia files from one format to another. We encoded and transcoded some multimedia files with FFmpeg, and for the iPod conversion we used HnadBrakeCLI. The impact during FFmpeg and iPod converting was almost the same (Performance Test, 2011).

Table 4. Encoding and transcoding speed some multimedia files with FFmpeg and HnadBrakeCLI

Anti-Virus	Score	Value
Avast	Very Fast	9
AVG	Very Fast	9
AVIRA	Very Fast	9
Bitdefender	Fast	7

eScan	Fast	7
ESET	Very Fast	9
F-Secure	Very Fast	9
G DATA	Mediocre	5
K7	Very Fast	9
Kaspersky	Very Fast	9
McAfee	Fast	7
Microsoft	Very Fast	9
Panda	Very Fast	9
PC Tools	Fast	7
Qihoo	Mediocre	5
Sophos	Very Fast	9
Symantec	Very Fast	9
Trend Micro	Fast	7
Trustport	Fast	7
Webroot	Very Fast	9

3.7. Installing and Uninstalling Application

We installed several programs (Like Visual C++, .Net Framework, etc.) with MSI installers, and then uninstalled them and measured how long it took. We did not consider fingerprinting, because usually an application is only installed once (Performance Test, 2011).

Table 5. Anti-viruses speed in terms of affecting on installation and deletion of software

Anti-Virus	Score	Value
Avast	Very Fast	9
AVG	Very Fast	9
AVIRA	Very Fast	9
Bitdefender	Fast	7
eScan	Fast	7
ESET	Very Fast	9
F-Secure	Very Fast	9
G DATA	Very Fast	9
K7	Very Fast	9
Kaspersky	Very Fast	9
McAfee	Very Fast	9
Microsoft	Very Fast	9
Panda	Very Fast	9
PC Tools	Very Fast	9
Qihoo	Fast	7
Sophos	Very Fast	9
Symantec	Very Fast	9
Trend Micro	Very Fast	9
Trustport	Fast	7
Webroot	Very Fast	9

3.8. Launching Application

Office document files are very common. We opened some large document files in Microsoft office and close it. Before each opening, the workstation was rebooted. The time taken for the viewer or edit application to open and a document to be displayed was measured. Although we list the result for the first opening and the subsequent openings, we consider the subsequent opening more important, as normally this operation is done several times by users, and optimization features of the Anti-Virus products take place, minimizing their impact on the system (Performance Test, 2010).

Table 6. Launching Application speed some multimedia files with FFmpeg and HnadBrakeCLI

Anti-Virus	Score	Value
Avast	Very Fast	9
AVG	Very Fast	9
AVIRA	Very Fast	9
Bitdefender	Very Fast	9
eScan	Very Fast	9
ESET	Very Fast	9
F-Secure	Very Fast	9
G DATA	Very Fast	9
K7	Very Fast	9
Kaspersky	Very Fast	9
McAfee	Very Fast	9
Microsoft	Very Fast	9
Panda	Very Fast	9
PC Tools	Very Fast	9
Qihoo	Fast	7
Sophos	Very Fast	9
Symantec	Very Fast	9
Trend Micro	Very Fast	9
Trustport	Fast	7
Webroot	Very Fast	9

4. Research Findings

results of test have been collected based on detection and missed samples, false positive/Alarm, scanning speed, file copying, archiving and unarchiving, encoding and transcoding, install/uninstall application and launching application.

Table 7. Results of tests based on the studied criteria

	C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	*C8*
A1	2.7	10	16.6	9	9	9	9	9
A2	4.3	57	11.6	9	9	9	9	9
A3	0.5	11	12.3	9	9	9	9	9
A4	1.6	8	10.5	9	7	7	7	9
A5	1.5	29	9.5	9	9	7	7	9
A6	2.7	3	9.8	9	9	9	9	9
A7	1.5	6	10.3	9	9	9	9	9
A8	0.3	14	10.1	9	7	5	9	9
A9	14.4	23	13.7	9	9	9	9	9
A10	1.7	1	9.9	9	9	9	9	9
A11	3.2	0	12.9	5	9	7	9	9
A12	7.7	1	7.1	9	9	9	9	9
A13	0.7	1	9.6	9	9	9	9	9
A14	11.6	45	7.7	7	3	7	9	9
A15	0.5	25	7.4	9	7	5	7	7
A16	5.8	16	11.1	9	9	9	9	9
A17	4.9	57	9.7	9	9	9	9	9
A18	3.4	6	15.3	7	7	7	9	9
A19	0.4	59	7.9	7	5	7	7	7
A20	5.8	16	10.2	9	9	9	9	9

This decision making problem has 20 options and 8 criteria and the result of options assessment for detection and missed samples, false positive/Alarm, scanning speed, file copying, archiving and unarchiving, encoding and transcoding, install/uninstall application and launching application as well as result of scale-less matrix with respect to formula X_{ij} are as follows and The scale for decision-making matrix norm method is used:

$$n_{ij} = \frac{X_{ij}}{\sqrt{\sum_{k=1}^{n} X_{kj}^2}}$$

Significance coefficients of these criteria by means of eigenvector are respectively as followings:

W = [0.215, 0.215, 0.215, 0.071, 0.071, 0.071, 0.071, 0.071]

Calculate the weighted normalized decision matrix : $v_{ij} = w_j n_{ij}$ $i = 1,2,\ldots,20$ $j = 1,2,\ldots,8$

Determine the positive ideal solution A^+ and negative ideal solution A^- as below:

For value C1 positive ideal $A^+ = \{0.0027\}$ and negative ideal $A^- = \{0.1309\}$

For value C2 positive ideal $A^+ = \{0.0000\}$ and negative ideal $A^- = \{0.1033\}$

For value C3 positive ideal $A^+ = \{0.0729\}$ and negative ideal $A^- = \{0.0311\}$

For value C4 positive ideal $A^+ = \{0.0166\}$ and negative ideal $A^- = \{0.0092\}$

For value C5 positive ideal $A^+ = \{0.0172\}$ and negative ideal $A^- = \{0.0057\}$

For value C6 positive ideal $A^+ = \{0.0176\}$ and negative ideal $A^- = \{0.0097\}$

For value C7 positive ideal $A^+ = \{0.0165\}$ and negative ideal $A^- = \{0.0128\}$

For value C8 positive ideal $A^+ = \{0.0161\}$ and negative ideal $A^- = \{0.0125\}$

0.1142	0.0814	0.3393	0.2348	0.2436	0.2480	0.2330	0.2281
0.1819	0.4642	0.2371	0.2348	0.2436	0.2480	0.2330	0.2281
0.0211	0.0895	0.2514	0.2348	0.2436	0.2480	0.2330	0.2281
0.0676	0.0651	0.2146	0.2348	0.1895	0.1929	0.1812	0.2281
0.0634	0.2361	0.1942	0.2348	0.2436	0.1929	0.1812	0.2281
0.1142	0.0244	0.2003	0.2348	0.2436	0.2480	0.2330	0.2281
0.0634	0.0488	0.2105	0.2348	0.2436	0.2480	0.2330	0.2281
0.0126	0.1140	0.2064	0.2348	0.1895	0.1378	0.2330	0.2281
0.6092	0.1873	0.2800	0.2348	0.2436	0.2480	0.2330	0.2281
0.0719	0.0081	0.2023	0.2348	0.2436	0.2480	0.2330	0.2281
0.1353	0	0.2637	0.1304	0.2436	0.1929	0.2330	0.2281
0.3258	0.0081	0.1451	0.2348	0.2436	0.2480	0.2330	0.2281
0.0296	0.0081	0.1962	0.2348	0.2436	0.2480	0.2330	0.2281
0.4908	0.3664	0.1574	0.1826	0.0812	0.1929	0.2330	0.2281
0.0211	0.2036	0.1512	0.2348	0.1895	0.1378	0.1812	0.1774
0.2454	0.1303	0.2269	0.2348	0.2436	0.2480	0.2330	0.2281
0.2073	0.4642	0.1983	0.2348	0.2436	0.2480	0.2330	0.2281
0.1438	0.0488	0.3127	0.1826	0.1895	0.1929	0.2330	0.2281
0.0169	0.4805	0.1615	0.1826	0.1353	0.1929	0.1812	0.1774
0.2454	0.1303	0.2085	0.2348	0.2436	0.2480	0.2330	0.2281

The separation of each alternative from the positive ideal solution (A^+) and the negative ideal solution (A^-) are given as below:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - v_j^+\right)^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - v_j^-\right)^2}$$

Table 8. Results of D_i^+ and D_i^-

D_i^+	*Score*	D_i^-	*Score*
D_1^+	0.0298	D_1^-	0.1439
D_2^+	0.1093	D_2^-	0.0954
D_3^+	0.0272	D_3^-	0.1544
D_4^+	0.034	D_4^-	0.1479
D_5^+	0.0612	D_5^-	0.1298
D_6^+	0.0388	D_6^-	0.1461
D_7^+	0.0324	D_7^-	0.1511
D_8^+	0.0387	D_8^-	0.1515
D_9^+	0.1372	D_9^-	0.0714
D_{10}^+	0.0331	D_{10}^-	0.1552
D_{11}^+	0.0341	D_{11}^-	0.1478
D_{12}^+	0.0812	D_{12}^-	0.1196
D_{13}^+	0.0314	D_{13}^-	0.162
D_{14}^+	0.1376	D_{14}^-	0.0362
D_{15}^+	0.0605	D_{15}^-	0.1401
D_{61}^+	0.0641	D_{61}^-	0.1112
D_{17}^+	0.1132	D_{17}^-	0.0888
D_{18}^+	0.0335	D_{18}^-	0.1415
D_{19}^+	0.1107	D_{19}^-	0.1275
D_{20}^+	0.0657	D_{20}^-	0.1106

Calculate the relative closeness of each alternative to the ideal solution. The relative closeness of the alternative A_i with respect to A^+ is defined as:

$$RC_i = \frac{D_i^+}{D_i^+ + D_i^-}$$

Table 8. Results of RC_i

RC_i	*Score*
RC_1	0.8280
RC_2	0.4661
RC_3	0.8499
RC_4	0.8128
RC_5	0.6794
RC_6	0.7900
RC_7	0.8231
RC_8	0.7963
RC_9	0.3423
RC_{10}	0.8242
RC_{11}	0.8125
RC_{12}	0.5954
RC_{13}	0.8375
RC_{14}	0.2084
RC_{15}	0.6984
RC_{16}	0.6343
RC_{17}	0.4396
RC_{18}	0.8085
RC_{19}	0.5352
RC_{20}	0.6273

5. Conclusion

The smaller the value of RC_i , the nearer it is close to the ideal solution. Therefore, A3 is the best alternative, and A14 is the worst alternative. In this assessment, option A14 i.e. PC Tools Spyware Doctor with Antivirus 2012 is the worst antivirus and As a result, Option A3 i.e. AVIRA Free Antivirus 2012 will be the best option. This Model according to the mentioned conditions is able to do the ranking repeatedly by updating number of antivirus and their criteria**.**

Acknowledgement

The author is grateful to Dr. Kaveh Teymournejad from School of Accounting & Management at Islamic Azad University Central Tehran Branch, for a thorough review and useful suggestion in the article.

Corresponding Author:

Department of Executive Management,
Faculty of Management and Accounting, Islamic Azad University (IAU), Qazvin Branch, Qazvin, Iran.
E-mail: Hesam.naie@yahoo.com
Tel: +989125932954

References

1. Post G. and ,Kagan A., The Use and Effectiveness of Anti-Virus Software, *Computers & Security* 1998: 17: 589–599.
2. Post G., Kievit K.A., Post Accessibility vs. Security: A Look at the Demand for Computer Security, *Computers & Security* 1991:10: 331–344.
3. Cohen F., A summary of recent results on computer viruses, *NET/DOD Annu. Co& on Computer Security,* 1990.
4. Cohen F., Computer Viruses Theory and Experiments, *Computers and Security* 1987: 6(1): 22–35.
5. Jose R.C. Piqueira, Adolfo A. de Vasconcelos, Carlos E.C.J. Gabriel and Vanessa O. Araujo. Dynamic models for computer viruses, *Computers & Security* 2008: 27 : 355–359.
6. Naie H., Kiani Mavi R. and Hamidi N. Assessment of the performances of 20 global Anti-Viruses by application of VIKOR method**,** *American Journal of Scientific Research* 2011:40: 46-58**.**
7. Fu G.L., Yang C. and Tzeng G.H., A multicriteria analysis on the strategies to open Taiwan's mobile virtual network operators services, *International Journal of Information Technology & Decision Making* 2007: 6 (1) : 85–112
8. Shi Y., Peng Y., Kou G. and Chen Z. Classifying credit card accounts for business intelligence and decision making: a multiple-criteria quadratic programming approach, *International Journal of Information Technology & Decision Making* 2005 : 4: 581–599.
9. Yu P.L. A class of solutions for group decision problems, *Management Science* 1973: 19 (8): 936–946.
10. Zeleny M. *Multiple Criteria Decision Making* (McGraw-Hill, New York, 1982.
11. Chen S.J. and Hwang C.L., *Fuzzy Multiple Attribute Decision Making: Methods and Applications* 1992.
12. Hwang, C. L., and Yoon, K. Multiple attribute decision making: Methods and applications, A State of the Art Survey. New York: Springer-Verlag. 1981.
13. Ertugrul, _I., and Karakasoglu, N. Performance evaluation of Turkish cement firms with fuzzy analytic hierarchy process and TOPSIS methods. Expert Systems with Applications 2007: 36(1) : 702–715.
14. Wang, Y. M., and Elhag, T. M. S. Fuzzy TOPSIS method based on alpha level sets with an application to bridge risk assessment. Expert Systems with Applications 2006: 31: 309–319.
15. Wang, Y. J. Applying FMCDM to evaluate financial performance of domestic airlines in Taiwan. Expert Systems with Applications. doi:10.1016/j.eswa.2007. 02.029.
16. Shih, H.-S., Shyur, H.-J. and Lee, E.S. Extension of TOPSIS for Group decision making.

Mathematical and Computer Modelling 2007: 45 (7–8): 801–813.
17. Chen, C. T. Extensions of the TOPSIS for group decision-making under fuzzy environment. Fuzzy Sets and Systems 2000: 114: 1–9.
18. Chu, T. C. Selecting plant location via a fuzzy TOPSIS approach. International Journal of Advanced Manufacturing Technology 2002: 20: 859–864.
19. Chu, T. C., and Lin, Y. C. Improved extensions of the TOPSIS for group decision making under fuzzy environment. Journa of Information and Optimization Sciences 2002: 23: 273–286.
20. Lai, Y. J., Liu, T. Y., and Hwang, C. L. TOPSIS for MODM. European Journal of Operational Research 1994: 76: 486–500.
21. Duckstein L. and Opricovic S., Multiobjective optimization in river basin development, Water Resources Research 1980: 16 (1): 14–20.
22. Dyer J.S., Fishburn P.C., Steuer R.E., Wallenius J. and Zionts S., Multiple criteria decision making, Multiattribute utility theory: The next ten years, Management Science 1992: 38 (5): 645–654.
23. On-Demand Comparative, Anti-Virus Comparative, 27 September 2011. URL: http://www.av-comparatives.org/en/comparativesreviews/retrospective-test
24.Performance Test, Anti-Virus Comparative, 8 December 2011. URL: http://www.av-comparatives.org/en/comparativesreviews/performance-tests

09/04/2012