ARPN Journal of Engineering and Applied Sciences
©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

ETHERNET SWITCHING MODE SELECTION USING AHP

Dhafer Taha Shihab and Ali J. Abboud
Department of Computer Engineering, College of Engineering, University of Diyala, Diyala, Iraq
E-Mail: dhafershihab@gmail.com

ABSTRACT

In this paper, a comparative analysis study is proposed to select the best Ethernet switching mode for a particular computer network requirement. The selected switching mode is reliant on variable factors and parameters in the computer networks. The three Ethernet switching modes which are used in this study are store and forward, Cut-through, and free fragment modes. One of three used switching modes in this study is selected using analytic hierarchy process (AHP) technique as per requirement of a user. AHP is multi criteria decision making instrument created by Thomas Saaty in the 1970s. The criteria or parameters which are used to select best Ethernet switching mode are: latency, function, performance, port density, and cost. The experimental results prove that fragment free switching mode is the best among three switching modes with (0.422) score.

Keywords: AHP, Ethernet switching mode, MCDM, alternatives, store and forward, cut through, fragment-free.

INTRODUCTION

Computer networks technology is growing rapidly at unexpected fastest rate [1]. Such advancement in the field of networking technology is getting more important to solve different kinds of challenging problems [2]. The Ethernet switching mode (ESM) is used recently extensively in modern computer networks [3], [4]. It figures out if the switch starts sending the frame when the switch has perused the destination information of interest in the package header or holds up until the whole frame has been gotten. Also, ESM checks the cyclic redundancy check (CRC) errors before sending packets to the network [5]. ESM deals with all the switched packets through the equipment that can be retained constantly through reboots and restarts [5]. The ESM switch operates in one of the following switching methods: (1) store and forward, (2) cut through, and (3) fragment-free [5]. Selecting the most appropriate Ethernet switching mode inside a network is the most difficult task since this implies that the decision based on multiple criteria of choices. This is eventually an extremely troublesome assignment problem that needs some techniques to resolve this issue.

AHP is the most appropriate candidate to tackle such issues. The present work utilizes AHP for choosing an appropriate Ethernet switching mode. AHP was used as a method for managing weapons trade-off, designing asset, resources and making decisions [6]. AHP is a decision-making tool based on different criteria that has been utilized as a part of the considerable number of utilizations related with the basic making of decision [7], [8]. Multiple criteria decision making is to select better choice of possible various and typically opposing alternatives [8], [9]. AHP is a multi-criteria decision-making procedure which permits the thought of both subjective and goal components for choosing the most appropriate option [10], [11].

AHP relies on three basic principles: analysis, pairwise comparison, and priority synthesis [12]. The principle of analysis means to break down choice issue into a hierarchy of necessary components problems'. While the pairwise comparison principle means to compare pairs of components inside a certain layer [12]. Finally, the principle of priority synthesis captures every determined proportion weight nearby ranks in the different hierarchy's levels and builds a synthesis group of priorities for the components at the most lower hierarchy's levels (i.e., choices) [12], [13], [14].

The rest of paper is organized as follows: section 2 is devoted to the Ethernet switching modes and selection criteria, section 3 is used to explain thoroughly the AHP technique, section 4 presents proposed performance comparative study and finally conclusions is presented in section 5.

ETHERNET SWITCHING MODES AND SELECTION CERTERIA

Local Area Network (LAN) switches support diverse switching modes including important Ethernet switching modes such as store-and-forward, cut-through, and fragment-free. This section presents these Ethernet switching modes thoroughly. In addition, the selection criteria for the most appropriate equipment switching mode will be explained.

ETHERNET SWITCHING MODES

Ethernet Switching Modes decide how a switch gets, treats, and directs an Ethernet frame. Ethernet switching modes are [15], [16]:

a) **Store-and-forward switching mode:** In this switching mode, each complete Ethernet frame is duplicated into the switch memory and CRC for errors is computed. In the event of mistake, CRC detects such event and the Ethernet frame is crashed. Otherwise, when there is no CRC blunder, the Ethernet frame is directed to the destination device. This mode can incur delay in switching since CRC is computed for every Ethernet frame.

b) **Cut-through switching mode:** In this switching mode, the initial 6 bytes MAC address of the Ethernet

ARPN Journal of Engineering and Applied Sciences
©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

frame is duplicated into its memory before deciding a switching choice. The switch in this mode decreases delay since the Ethernet frame is forwarded immediately as the MAC address and the active switch port are decided. The only problem in this mode is that the faulty Ethernet frames may be sent.

c) **Fragment free switching mode:** This mode is a derived form of cut through switching mode. The platforms which use cut-through mode will read MAC address field in the Ethernet package and then creates a forwarding choice. While, the platforms in which use fragment free switching mode interpret no less than 64 bytes of the Ethernet package and then switch it to prevent sending runt, or less than 64 bytes Ethernet frames.

SELECTION CERTERIA

Several criteria are used to select the Ethernet switching mode, these criteria are explained below [17], [18]:

a) Latency**:** Ethernet switch latency is the time that switches need to forward a package from its entrance port to its departure port. The lower latency means less time the package stays in the switch holding up to be prepared while the faster latency means the quicker the package can be sent to the intended host. Also, it is vital to comprehend the phrasing of switch latency in different switching strategies and the system to acquire the most exact latency estimations. Numerous variables can influence the precision of the latency estimation results such as the position of the time stamp in test package, and the movement rate and style, and so forth.

b) Function**:** Once the required switching platform function is determined, the functional and operational requirements satisfaction is checked such that switches performance neither decreasing nor latency increasing.

c) Performance**:** It means satisfy rigorous application requirements within specific time limit. To meet such strict requirements, the switch either uphold wire rate performing on all ports with the required arranged attributes or have less performance limits to be suitable alternative in such performance constraints.

d) Port Density**:** It is the number of ports available on a single switch.

e) Cost**:** It means the aggregate expense of supporting and running a switch in the information centre. The cost must include the cost of the switch itself, the design staff and the usage operations. Enterprises additionally require to take into account the accessibility of advanced responsive and proactive observing tools and their general impact on decreasing the required time in order to investigate and repair any drawback that possibly will happen.

THE ANALYTICAL HIERARCHY PROCESS

The analytical hierarchy process is a technique for separating the issue into a chain of sub issues. They can more easily subjectively comprehended and evaluated. AHP converts the subjective assessments into numerical values. Then prepares them to arrange every option, alternatives, on a numerical measure. The steps of AHP are [18] [19] [20]:

Step1: In this step, the problem is decomposed into a hierarchy of important of objectives (or goals), criteria, sub-criteria and choices (or alternatives). It is the highest inventive and critical part of decision-support. Generic hierarchy structure is shown in Figure-1. The objective of the problem being studied and analysed is located at the root of the hierarchy. The comparison alternatives are the leaf nodes. Different criteria and sub-criteria are being included in between those two levels. It is important that the relation of the lower level elements to the upper ones must be taken in consideration when a decision - maker compares elements at each level. Having the ability to concentrate selectively on specific parts of the whole problem is an excellent property of the AHP. This is an effective characteristic of the AHP because local focusing of the decision maker is on just part of the entire problem.

Step 2: In this step, the information is gathered from decision makers or specialists relating to the hierarchic structure, in the pair wise judgment of options on a qualitative measure as portrayed underneath. Decision makers can rate the judgment as extremely strong, very strong, strong, marginally strong, and equal. The judgment can be gathered in a particularly planned arrangement as appeared in Figure-2. The section with the symbol "✓" noted as, "strong", shows that

A is strong evaluated with B as far as the standard on which the correlation is being made. According to Table -1, the evaluations are made for every standard then converted over into numerical factors.

Step 3: In this step, the pairwise judgments are composed into an (N x N) matrix for the different standards and criteria created at step 2. The values of the diagonal in the matrix are equal to 1. In the comparison matrix, if the scale of $(i, j)^{th}$ element is greater than 1, it means that the standard in the i^{th} line is superior to criterion in the j^{th} column; if not, the standard in the j^{th} column is superior to that in the i^{th} line. In the comparison matrix, the (j, i) component is 1/ (i, j) component.

Step 4: Using the rule of eigenvalue with the relating standardized right eigenvector of the obtained matrix from step 3, gives the relative significances and priorities of the different criteria being analysed. The elements of the standardized eigenvector are named weights with respect to the criteria or sub criteria and rankings regarding to the choices (alternatives).

Step 5: In this step, the consistency is measured for the matrix of rank n. The subjective comparisons using AHP allows discrepancy via the measure of redundancy in the method. In the event that fail to access to proper consistency, index comparisons should be reconsidered.

VOL. 13, NO. 23, DECEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences
©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

Step 6: In this step, the weight for every alternative is multiplied by the weight for each sub criteria and aggregated to obtain local evaluations regarding every criterion. Multiplying the local evaluations by the weights of the criteria and aggregating them to obtain overall valuations. For every option and alternative, the AHP produces weight values based on the judged significance of an option and alternative over another respecting to a shared criterion. The option which has maximum weight value or eigenvalue or importance will be picked.

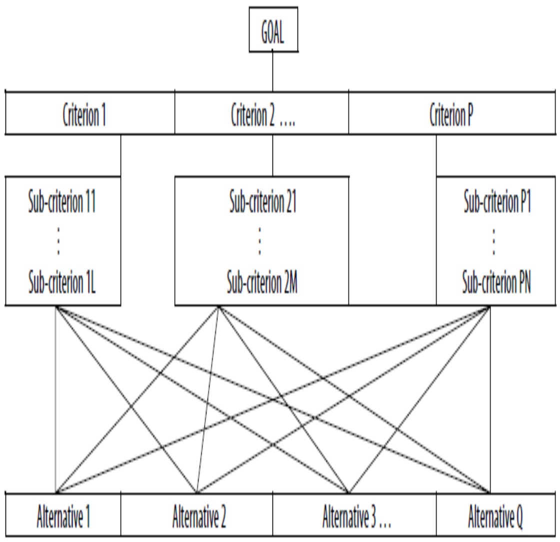

Figure-1. Generic hierarchic structure.

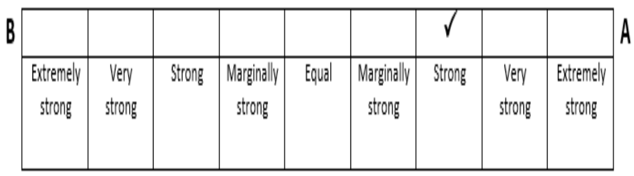

Figure-2. Format for pairwise comparisons.

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

PROPOSED PERFORMANCE COMPARATIVE STUDY

In this work, one of three explained earlier Ethernet switching modes described in section 2 is selected according to prerequisites of client. By utilizing AHP technique explained in last section 3, the best Ethernet switching mode as indicated by client prerequisites is picked.First, the hierarchical structure for the options (alternatives) of this work is demonstrated as shown in Figure-3. Second, constructing the matrix of pairwise comparisons by using pair wise comparisons. We look at choices in pairs. This gives a possibility to create a relative scale to calculate the amount we like the criteria or Ethernet switching mode on the right to be compared with the criteria or Ethernet switching mode on the left. In order to achieve the objective (the goal), we have to compare the variables with respect to their significance.

Figure-4 demonstrates the relative values comparing the factors. Third, AHP locates the relative priorities of criteria or options, alternatives, suggested by these comparisons. The relative priorities are worked out utilizing the concept of eigenvector. What is more, the consistency check ought to be done at every phase of the choice procedure. There are three elements from the analysis that are required to assess the consistency of the acquired result which are consistency index (CI), random consistency index (RI), and consistency ratio (CR) [21]. Following procedures are utilized to decide the above mentioned components of computation. Wherever *(M×M)* is the size of matrix, weights are computed from the comparison matrices. After putting the values in every cell of the matrix, the initial step would sum the value of the columns. Next, the summations of values of the columns would be matched, after that every column summation has already divided the entirety summation of the columns to find the weights of the factors/ criteria of Ethernet switching mode.

To calculate the CI, RI and CR, the following formulas are used [22].

$$CI = \frac{\lambda \max - n}{n - 1} \tag{1}$$

$$RI = 1.98\,\frac{n-2}{n} \tag{2}$$

$$CR = \frac{CI}{RI} \tag{3}$$

λ_{max} :The greatest eigenvalue.

n : The size of the pairwise comparison matrix.

Thus the CR should be <= 0.1

VOL. 13, NO. 23, DECEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences
©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

It is constantly sensible that the value of CR must be less than or equivalent to 0.1 or 10%, then the calculated result is said to be acceptable or consistent. If not, i.e. the value of CR is greater than 0.1 or 10%, the calculated result should be reconsidered [23, 24]. To get the composite score of every element, at the last step of the computation, the general favourite matrix would be created by multiplying every one of the weights for the alternatives with the weights of the elements (factors), where in this way the outcomes are added [25]. All the comparison matrices are shown in the Table-2 to Table-7. The final composite scores are illustrated in Table-8 and Table-9 presents the CI, CR values accomplished. At last, Figure-5 introduces the result of the choice of Ethernet switching mode. The final scores for each mode are shown below:

For the Store-and-forward alternative, the score was 0.234.

For the Cut-through alternative, the score was 0.337.

For the Fragment-free alternative, the score was 0.422.

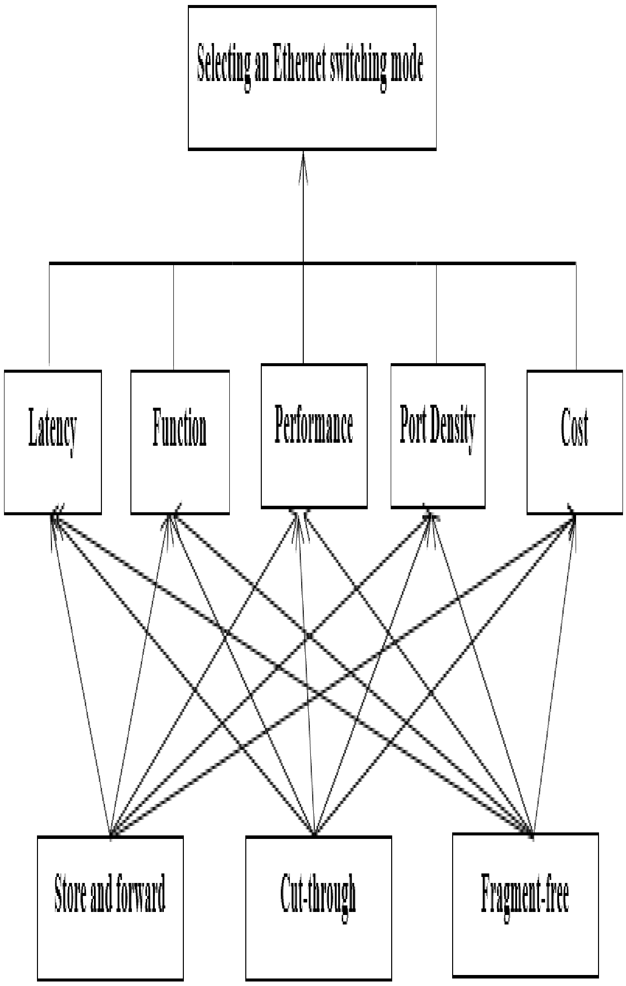

Figure-3. Hierarchy structure.

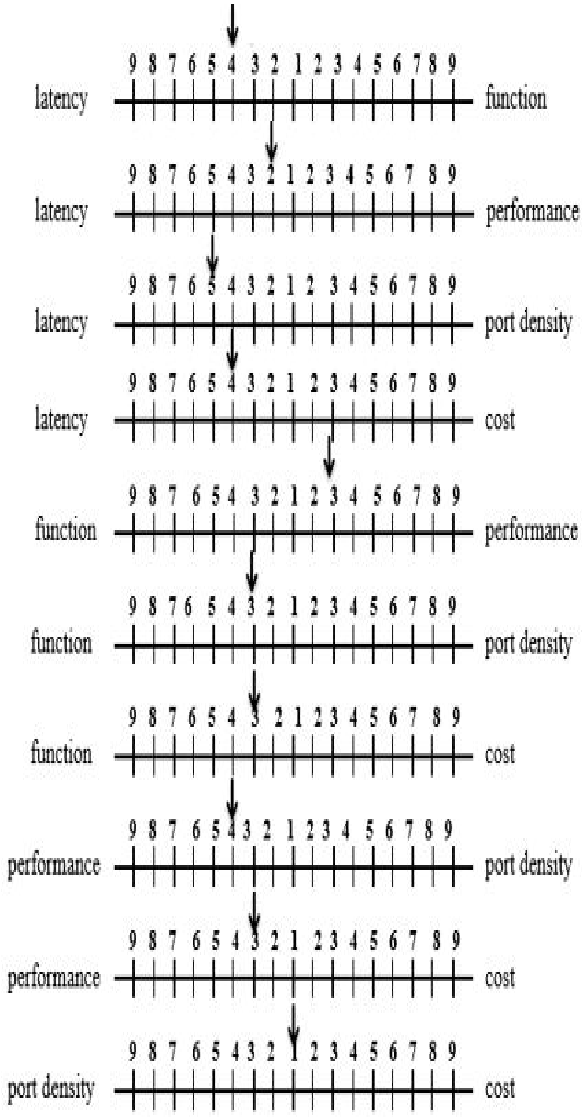

Figure-4. Relative scale comparing factors.

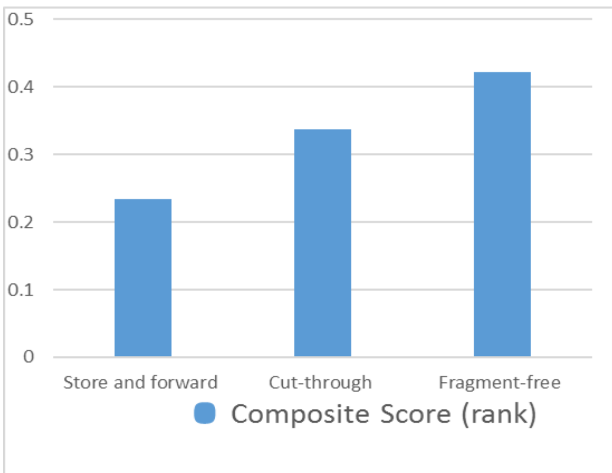

Figure-5. Composite score plot of the Ethernet switching mode.

©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

Table-2. Comparison matrix for criteria.

latency	function	Performa nce	Port density	cost	Priority weight
1	4	2	5	4	0.430
1/4	1	1/3	3	3	0.147
1/2	3	1	4	3	0.277
1/5	1/3	1/4	1	1	0.068
1/4	1/3	1/3	1	1	0.076

Table-3. Comparison matrix for criteria under **latency** criterion.

latency	Store and forward	Cut-through	Fragment-free	Priority weight
store and forward	1	1	1/2	0.259
Cut-through	1	1	1	0.327
Fragment-free	2	1	1	0.412

Table-4. Comparison matrix for criteria under **function** criterion.

function	Store and forward	Cut-through	Fragment-free	Priority weight
Store and forward	1	1/7	1/5	0.077
Cut-through	7	1	1	0.486
Fragment-free	5	1	1	0.435

Table-5. Comparison matrix for criteria under **performance** criterion.

Performance	Store and forward	Cut-through	Fragment-free	Priority weight
Store and forward	1	1/2	1/3	0.169
Cut-through	2	1	1	0.387
Fragment-free	3	1	1	0.443

Table-6. Comparison matrix for criteria under port density.

Port Density	Store and forward	Cut-through	Fragment-free	Priority weight
Store and forward	1	1/2	1/5	0.122
Cut-through	2	1	1/3	0.229
Fragment-free	5	3	1	0.648

Table-7. Comparison matrix for criteria under **cost** criterion.

cost	Store and forward	Cut-through	Fragment-free	Priority weight
Store and forward	1	9	5	0.742
Cut-through	1/9	1	1/4	0.063
Fragment-free	1/5	4	1	0.194

©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

Table-8. Weights of alternatives.

	Latency 0.430	**function 0.147**	**Perf. 0.277**	**Port Density 0.068**	**cost 0.076**	**WoA**
Store and forward	0.529	0.077	0.169	0.122	0.742	0.234
Cut-through	0.327	0.486	0.387	0.229	0.063	0.337
Fragment -free	0.412	0.435	0.443	0.648	0.194	0.422

Where Perf. And WoA mean performance and weights of alternatives.

Table-9. CI, RI, CR values for all the pairwise comparison matrices.

	latency	**function**	**Perf.**	**Port Density**	**cost**	**Between criteria**
CI	0.026	0.007	0.009	0.002	0.036	0.042
RI	0.58	0.58	0.58	0.58	0.58	1.12
CR	0.046	0.012	0.016	0.004	0.063	0.037

CONCLUSIONS

For selecting the best Ethernet switching mode, multi criteria decision supporting methods (based on different criteria) are employed. The AHP is very helpful toolfor evaluating many alternatives which are based on multi criteria. Using AHP procedure on the given data in pair wise comparison matrix for the criteria and the pairwise comparison matrix for the alternatives with respect to these criteria, the final score, rank or priority for the best alternative (Ethernet switching mode) have been gotten. In the wake of applying AHP strategies, Fragment-free Ethernet switching mode has the most elevated score/priority/weight which demonstrates that Fragment-free is the most reasonable Ethernet switching mode for a client because the fragment free Ethernet switching mode decreases latency inside the switch. Therefore, we can securely presume that AHP can be utilized for the choice of Ethernet switching mode.

REFERENCES

[1] Abboud A. J. and Jassim S. A. 2012.Biometric Templates Selection and Update Using Quality Measures. In Mobile Multimedia/Image Processing, Security, and Applications 2012, SPIE, 8406: 840609.

[2] Abboud A. J. and Jassim S. A. 2010. Image Quality Guided Approach for Adaptive Modelling of Biometric Intra-Class Variations. In Mobile Multimedia/Image Processing, Security, and Applications 2010, SPIE, 7708: 77080 L.

[3] Abboud A. J. and Jassim S. A. 2012. Incremental fusion of partial biometric information. In: Mobile Multimedia/Image Processing, Security and Applications 2012, SPIE, 8406: 84060K.

[4] Al-Assam H., Abboud A., Sellahewa H. and Jassim S. 2012.Exploiting Relative Entropy and Quality Analysis in Cumulative Partial Biometric Fusion. In Transactions on Data Hiding and Multimedia Security, III: 1-18. Springer, Berlin, Heidelberg.

[5] Cisco Nexus 3000 NX-, 2012.OS Layer 2 Switching Configuration Guide. Release 5.0 (3) U3(1).

[6] Saaty T. L. 2008.Decision Making with the Analytic Hierarchy Process. International journal of services sciences. 1(1): 83-98.

[7] Abboud A. J., Sellahewa H. and Jassim S. A. 2009. Quality Based Approach for Adaptive Face Recognition. In: Mobile Multimedia/Image Processing, Security, and Applications 2009, SPIE, 7351: 73510N.

[8] Vaidya O. S. and Kumar S. 2006.Analytic Hierarchy Process: An Overview of Applications. European Journal of Operational Research. 169(1): 1-29.

[9] Al-Assam H., Abboud A. and Jassim S. 2011. Hidden Assumption of Face Recognition Evaluation under Different Quality Conditions. In: IEEE International Conference on Information Society (i-Society). pp. 27-32.

©2006-2018 Asian Research Publishing Network (ARPN). All rights reserved.

[10] Chaudhary V., Kaur K. and Rani M. 2014.Operating System Selection Using AHP on The Basis of Security Performance and Cost. International Journal of Computing and Business Research (IJCBR). 5(2): 1-13.

[11] Jassim A. J., Al-Assam H., Abboud A. J. and Sellahewa H. 2010.Analysis of Relative Entropy, Accuracy and Quality of Face Biometric. In Proceedings of the Workshop on Pattern Recognition for IT.

[12] Saaty R. W. 1987.The Analytic Hierarchy Process What it is and how it is used. Mathematical Modelling. 9(3-5): 161-176.

[13] Al-Assam H., Abboud A. and Jassim S. 2011. Exploiting Samples Quality in Evaluating and Improving Performance of Biometric Systems. International Journal of Digital Society (IJDS). 2(2): 462-468.

[14] Eldrandaly K., Eldin N. and Sui D. 2003.A COM-Based Spatial Decision Support System for Industrial Site Selection. Journal of Geographic Information and Decision Analysis. 7(2): 72-92.

[15] Cisco Systems corporation. 2008. Cut-Through and Store-and-Forward Ethernet Switching for Low-Latency Environments. pp. 1-13.

[16] Abboud A. J. 2015. Multifactor Authentication for Software Protection. 8(4): 479-492.

[17] Abboud A. J. 2011. Quality Aware Adaptive Biometric Systems. Ph.D. Thesis, UK, University of Buckingham, British Library, EthOS.

[18] Bhushan N. and Rai K. 2007. Strategic Decision Making: Applying the Analytic Hierarchy Process. Springer Science and Business Media.

[19] Abboud A. 2015. Protecting Documents Using Visual Cryptography. International Journal of Engineering Research and General Science. 3(2): 464-470.

[20] Abboud A. J. and Saleh O. S.Sustainable IT: A Realisation Survey among Academic Institutions of Iraq. International Journal of Enhanced Research in Science Technology and Engineering. 3(2): 25-31.

[21] Deng X., Hu Y., Deng Y. and Mahadevan S. 2014. Supplier Selection Using AHP Methodology Extended by D Numbers. Expert Systems with Applications. 41(1): 156-167.

[22] Chakraborty T., Ghosh T.and Dan P. K. 2011. Application of Analytic Hierarchy Process and Heuristic Algorithm in Solving Vendor Selection Problem. Business Intelligence Journal. 4(1): 167-177.

[23] Hartono W. I. D. I., Mufti A., Marwoto S. O. F. A. and Laksito B. U. D. I. 2016. Application of AHP Method for Determining the Priority of Puskesmas Pembantu Building Maintenance Based on GIS in Sukoharjo District Central of Java. Applied Mechanics and Materials. 845: 318-325.

[24] Desai A. R. and Bhagat S. S. 2018. Analysis of Suitable Locations of Urban Green Space Based on AHP for Surat city. Journal of Recent Activities in Infrastructure Science. 2(2): 1-10.

[25] Baidya R., Dey P. K., Ghosh S. K. and Petridis K. 2018. Strategic Maintenance Technique Selection Using Combined Quality Function Deployment, the Analytic Hierarchy Process and the Benefit of Doubt Approach. The International Journal of Advanced Manufacturing Technology. 94(1-4): 31-44.