Correlations and Weights of Fibosis-4 (FBI) for Liver Cirrhosis

Tamer Sh. Mazen

ABSTRACT
Hepatitis C virus (HCV) infection and its complications are one of the most leading health challenges over the world.Where it causes tissue damage, causing cirrhosis of the liver gradually. Liver biopsy and Fibro-scan are the standard methods to measure fibrosis before treatment. however, those methods have its own limitations, risks and cost.Liver fibrosis has been determined usingroutine laboratory tests. The laboratory tests are *Alanine* Aminotransferase (ALT), aspartate aminotransferase (AST), platelet count (PLT) and patient age. The aim of this paper, determine effectiveness weights of each laboratoryusing correlation coefficient and analytical hierarchy process.

General Terms
Liver disease

Keywords
Cirrhosis, Liver, Analytic Hierarchy Process (AHP), Correlation coefficient.

1. INTRODUCTION
Hepatitis C virus (HCV) infection is a serious human liver health problem. HCV is one of the most dangerous viruses on the liver and most prevalent. It spreads through the blood contact [1].

The natural course of chronic hepatitis C is characterized by progressive fibrosis in the inflamed liver with structural and hemodynamic changes leading to cirrhosis, which is followed by end stage complications. Accordingly,the assessment of liver fibrosis in chronic hepatitis C has become of paramount importance; to guide management decisions, predict outcome (prognosis), and monitor disease activity in individual patients [2].

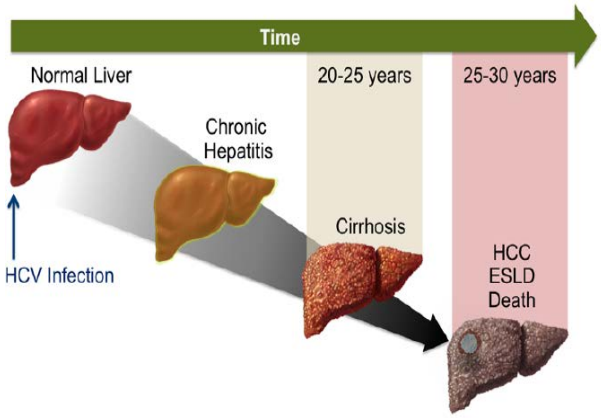

Fig.1: Time Course of Progression with Chronic Hepatitis C Infection

Fig.1, represent liver's tissue phases that infected by HCV according life time. According Fig. 1 cirrhosis has 4 levels, F1, F2, F3 and F4 [2].

Masahiko Koda et el [3],presented a simple model consisting of routine laboratory tests. a simple Firbo-Index measurement has been created. the experiment was run on 240 patients whose tested by Fibro-scan. A fibro index equation has been created using platelet count, AST, and serum gamma globulin.

Dakshata Panchal and Seema Shah [4], presented an intelligent system to diagnosis of the Hepatitis B virus disease using as generalized regression and neural network which gives the result for whether the patient is Hepatitis B positive or not and the severity of the patient.

GhumbreShashikant and A.A. Ghatol [5], proposed a Neural network algorithm in conventional hepatitis B diagnosis that worked on basis of logical inference utilized to make a decision on the type of hepatitis that is likely to appear for a patient if it is hepatitis B or not. The kohonen Self-Organizing Map network(SOM) was applied to hepatitis data for predictions regarding the Hepatitis B which gives severity level on the patient. It is a class of unsupervised network was used as a classifier to predict the accuracy of Hepatitis B. The proposed model gives faster and more accurate prediction of hepatitis B and it works as promising tool for predicting of routine hepatitis B from the clinical laboratory data.

2. Background

In this research applying some statistical and probabilistic approach due to the random nature of the variables affected the fibrosis. It is obvious without proof that fibro index well correlation coefficient and analytical hierarchy process. So in the following a review for these concepts will be given.

2.1 Correlation coefficient
A correlation coefficient is a statistical measure of the degree to which changes to the value of one variable predict change to the value of another. In positively correlated variables, the value increases or decreases in tandem. In negatively correlated variables, the value of one increases as the value of the other decreases [6].

- *Tamer Sh. MazenLecturer, Dept. of Management Information Systems, Modern Academy for Computer Science and Information Technology, Cairo, Egypt*

Correlation coefficients are expressed as values between +1 and -1. A coefficient of +1 indicates a perfect positive correlation: A change in the value of one variable will predict a change in the same direction in the second variable. A coefficient of -1 indicates a perfect negative correlation: A change in the value of one variable predicts a change in the opposite direction in the second variable. Lesser degrees of correlation are expressed as non-zero decimals. A coefficient of zero indicates there is no discernible relationship between fluctuations of the variables [6].

There are some steps to calculate correlation coefficient. The data which working with are paired data, each pair of which will be denoted by (xi, yi).

The quantities from these calculations will be used in subsequent steps of calculation. First, the mean of the entire first and second coordinate data Xi & Yi is calculated. Then, calculated the standard deviation of first and second coordinates of the data Xi & Yi [6].

Using following equation to calculate correlation coefficient

$$r = \frac{n(\sum XY)-(\sum X)(\sum Y)}{\sqrt{[n\sum X^2-(\sum X^2)][n\sum Y^2-(\sum XY^2)]}} \quad \text{.....(1)}$$

2.2 Analytical Hierarchy Process Calculation

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology, It is a multi-criteria decision-making approach [7] [8].

To compute AHP we have four steps. First step: estimation of the pertinent data, but estimated in matrix A. It has relied on Intensity of Importance for parameters.

Table 1 illustrates Intensity of Importance Scale according to Saaty [7] [8]

TABLE 1: INTENSITY OF THE IMPORTANCE SCALE

Intensity of Importance	Definition
1	Objectives *i* and *j* are of equal importance.
3	Objective *i* is weakly more important than *j*.
5	Objective *i* is strongly more important than *j*.
7	Objective *i* is very strongly more important than*j*.
9	Objective *i*is absolutely more important than *j*.
2, 4, 6, 8	Intermediate values.

The second step is copying matrix A to matrix B. The third step is squaring the matrix by multiplying matrix A by B and fourth step is computing the eigenvector.

2.3 Fibro Index

Fibrosis-4 score uses to estimate cirrhosis. Cirrhosis has estimated using four parameters (Age, SGOT, SGPT and PLT) [8]. Fibrosis-4 estimated by [9]

$$FBI = \frac{Age \times AST}{PLT \times \sqrt[2]{ALT}} \quad \text{.....(2)}$$

Where:

Aspartate Aminotransferase (AST or SGOT)[U/L]
Alanine Aminotransferase (ALT or SGPT)$[U/L])^{1/2}$
Platelet Count (PLT) $[10^9/L]$

3. RESEARCH EXPERIEMENT

As mentioned before dealing with cirrhosis level.Calculating the Correlation Coefficient for each parameter versus other parameter is necessary.

3.1 Correlation Coefficient Calculation

Determine the correlation between each parameter of theFibrosis-4 with the other parameters and with the Fibrosis itself. These are presented in forms of propagation in Fig.-7consequently.

3.1.1 Aspartate Aminotransferase (AST or SGOT)Correlations

Using a simple correlation analysis between two variables, and apply it toSGOT vs. SGPT, SGOTvs. PLT and SGOT vs. Fibrosis-4.
Reached, that the correlation between SGOT vs. SGPT is an extreme correlation with value 0.792.As seen in Fig., where X axis represented SGOT and Y axis represented SGPT, dots represented intersection between SGOT values and SGPT values for each function sequentially and line represent correlation coefficient between SGOT and SGPT.

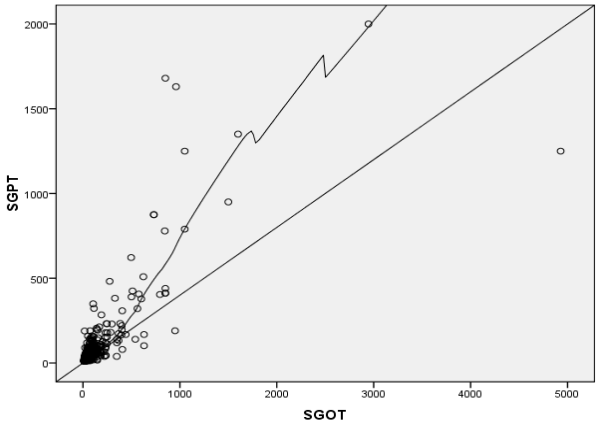

Fig.2: Correlation Coefficient between SGOT vs. SGPT

Also, there is no linear relationship between SGOT vs. PLT, where the correlation value -0.084 is close to zero. As seen in Fig. 3, where X axis represented SPOT and Y axis represented PLT, dots represented intersection between SGOT values and PLT values for each function sequentially and line represent correlation coefficient between SGOT and SGPT.

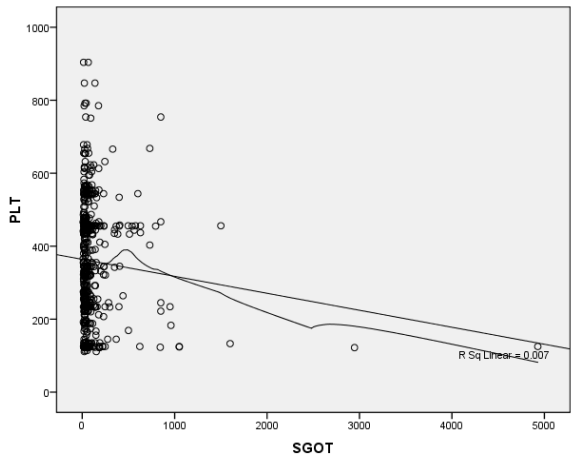

Fig.3: Correlation Coefficient between SGOT vs. PLT

However, there is a very strong extrusive correlation between SGOT vs. FBI with value 0.815 as. As seen in Fig. 4. where X axis represented SGOT and Y axis represented FBI, dots represented intersection between SGOT values and FBI valuesfor each function sequentially and line represent correlation coefficient between SGOT and FBI.

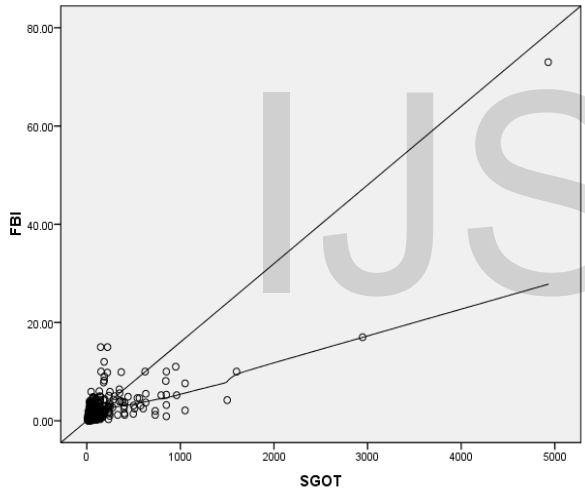

Fig. 4: Correlation Coefficient between SGOT vs. PLT

3.1.2 *Alanine Aminotransferase (ALT or SGPT) Correlations*

Also Appling simple correlation coefficient for SGPT vs. PLT and SGPT vs. Fibrosis-4.Reaching that the correlation between SGPT vs. FBI is moderate correlation with value 0.436. As seen inFig., where X axis represented SGPT and Y axis represented Firosis-4, dots represented intersection between SGPT values and FBI values foreach function sequentially and line represent correlation coefficient between SGPT and FBI.

However, there is no linear relationship between SGPT vs. PLT with value -0.045. As seen inFig. 6., where X axis represented SGPT and Y axis represented PLT, dots represented intersection between SGPT values and PLT values foreach function sequentially and line represent correlation coefficient between SGPT and PLT.

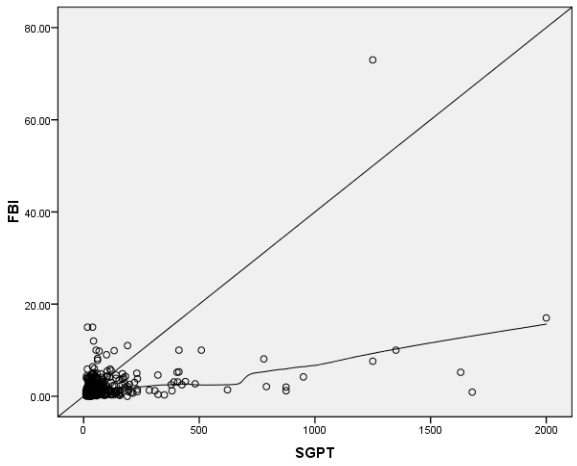

Fig. 5: Correlation Coefficient between SGPT vs. FBI

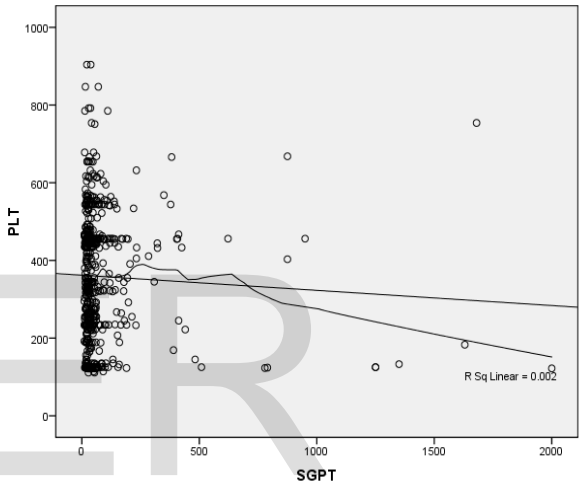

Fig. 6: Correlation Coefficient between SGPT vs. PLT

3.1.3 *Platelet Count (PLT) Correlation*

Also as seen in the correlation between PLT vs. Fibrosis-4 is inverse correlation with value -0.278. as seen in Fig. 7 where X axis represented PLT and Y axis represented FBI, dots represented intersection between PLT values and FBI values for each function sequentially and line represent correlation coefficient between PLT and FBI.

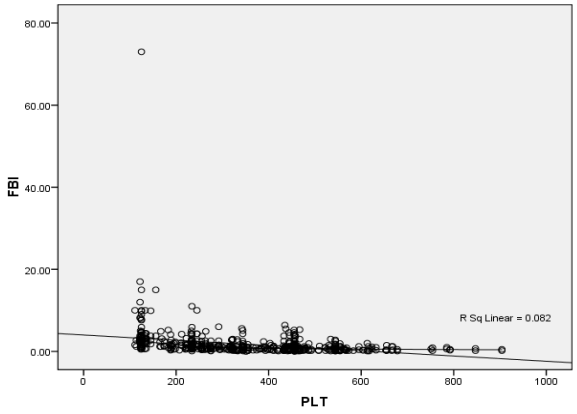

Fig. 7: Correlation Coefficient between PLT vs. FBI

3.1.4 Age Correlation

Finally, as seen in the correlation between Age vs. Fibrosis-4 is strong extrusivewith value .171. as seen in Fig. 8 where X axis represented age and Y axis represented FBI, dots represented intersection between age values and FBI values for each function sequentially and line represent correlation coefficient between age and FBI.

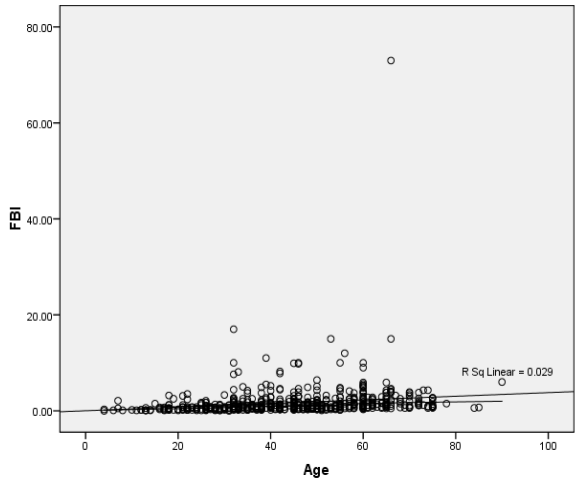

Fig. 8: Correlation Coefficient between Age vs. FBI

However, there is no linear relationship between Age vs. SGOT with value -0.02. As seen inFig. 9 where X axis represented Age and Y axis represented SGOT, dots represented intersection between Age values and SGOT values foreach function sequentially and line represent correlation coefficient between Age and SGOT.

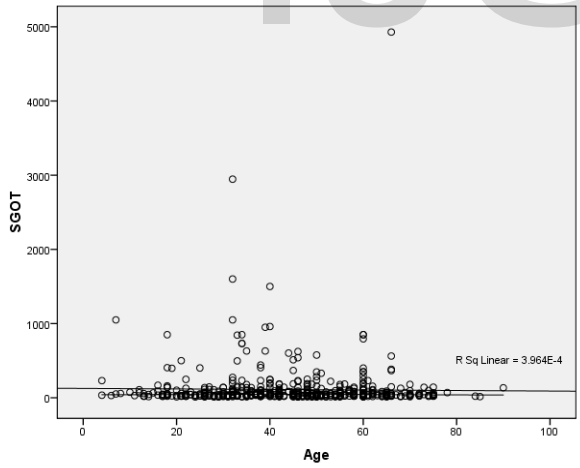

Fig. 9: Correlation Coefficient between Age vs. SGOT

Also, there is no linear relationship between Age vs. PLTwhere correlation value is 0.042 and it is closed to zero. As seen in10, where X axis represented Age and Y axis represented PLT, dots represented intersection between Age values and PLT values foreach function sequentially and line represent correlation coefficient between Age and PLT.

Otherwisethere is a very weak relationship between Age vs. SGPT with value -0.087. As seen inFig. 11 where X axis represented Age and Y axis represented SGPT, dots represented intersection between Age values and SGPT values foreach function sequentially and line represent correlation coefficient between Age and SGPT.

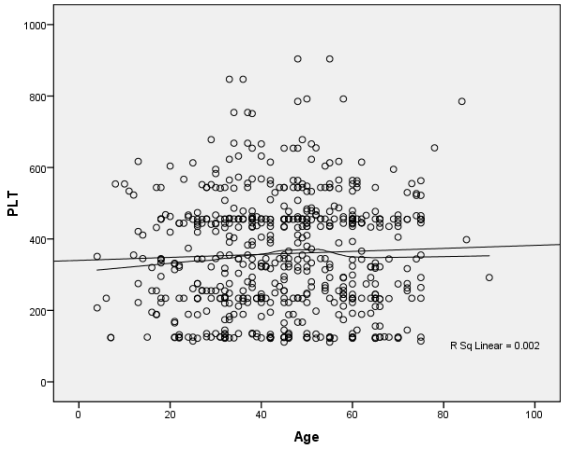

Fig. 10: Correlation Coefficient between Age vs. PLT

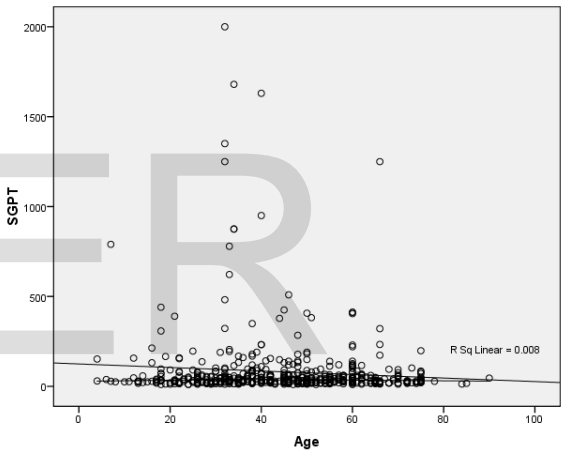

Fig. 11: Correlation Coefficient between Age vs. SGPT

3.2 Analytical Hierarchy Process Calculation

In this phase computing AHP for Fibrosis-4Parameters (SGPT, SGOT, PLT and Age).The priority of each component based on correlation coefficient results for each parameter and other one.Assume the maximum correlation coefficient be the main parameter is very strongly more important than another parameter, the middling correlation coefficient be the main strongly more important anther parameter and the minimum correlation coefficient be the main weakly more important anther parameter.

Using AHP methodology and according to correlation coefficient results, where the correlation coefficient between SGOT vs. SGPT is heights result.So assume that the priority for SGOT with SGPT by 7; so the priority for SGPT with SGOT is 1/7, where the correlation coefficient for SGOT vs. PLT is weakly so the priority for SGOT with PLT is 3; so the priority for PLT with SGPT priority is 1/3, and where correlation coefficient between SGOT vs. Age the priority for

SGOT with Age is 5; so the priority for Age with SGOT is 1/3. A priority for SGPT vs. PLT is 5, SGPT vs. Age is 3 and PLT vs. is 5. Table 2 illustrate the priories between parameters.

TABLE 2: PRIORITY FOR EACH PARAMETER VS. ANOTHER PARAMETER

	SGOT	*SGPT*	*PLT*	*Age*
SGOT	*1*	*7*	*3*	*5*
SGPT	$1/7$	*1*	$1/5$	$1/3$
PLT	$1/3$	*5*	*1*	$1/5$
Age	$1/5$	*3*	*5*	*1*

Table 3and Fig.12shows the SGOT is the most important parameter for computing Fibrrosis-4 with weight 53.14%, the Age is second important parameter with weight 25.08%, the third important parameter is PLT with weight 16.27% and finally SGPT is lower weight by 5.51%.

TABLE 3: WEIGHT VALUE FOR EACH PARAMETER

	AHP Result	Percentage
SGOT	53.1371	53.14%
SGPT	5.51217	5.51%
PLT	16.26679	16.27%
Age	25.08394	25.08%

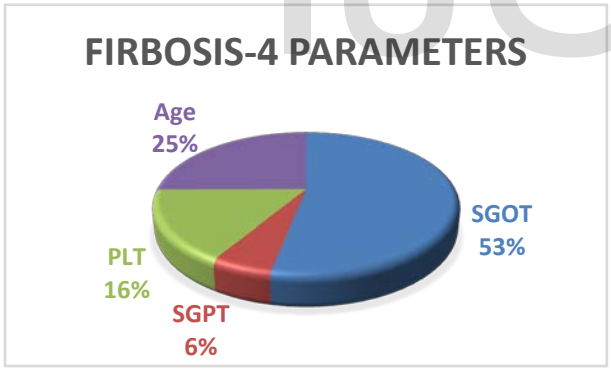

Fig.12: Weight of Fibrosis-4 parameters

Finally check Random index" RI" for results. represents an average consistency index"CI" for a huge number of randomly generated matrices of the same order. One can view it as an expected RI, so CR is the ratio between your consistency index and the expected one. The bigger it is, the worse your data is, by that measure. However, one should keep in mind that there is no definite measure of the "quality" of data in the decision theory [7]. The CI value is 0.06919427. from Random Index Tablehas been illustrated by saaty RI is 0.90.

So Degree of persistence = $\frac{CI}{RI} = \frac{0.06919427}{0.90} = 0.07688252$

Where the Degree of persistence = .08006,that mean that Degree of persistence is satisfying where Degree of persistence less than 0.1.

4. CONCLISION

In this research, in order to calculate the Fibrosis-4of cirrhosis levels. Cirrhosis determines by Fibro-Index. Fibro- index equation has 4 inputs (SGOT,SGPT, PLT and Age). this research computes the weight of each input using AHP. Model has been built based on the coefficient between inputs. correlation coefficient model,practically proved that there is a relation between SGPT and SGOT but there is no relation or very weak relation between other inputs.

Finally,by using Analytical Hierarchy Process, practically proved that the most important inputs which effect on Fibrosis is SGOT with weight value about 53%, the second input is Age with weight value about 25%, the third input is PLT with value 16% and thelastinput is SGPT with weight value about 5%.

5. REFERENCES

[1] HelenS.Te, DonaldM.Jensen, "Epidemiology ofHepatitis B and CViruses: A GlobalOverview",Clin Liver Dis. 2010

[2] Alberti A,"Natural History of Hepatitis C Infection", Hepatitis C Online,2017.

[3] Masahiko Koda,Yoshiko Matunaga,Manri Kawakami, et el, "FibroIndex, a Practical Index for Predicting SignificantFibrosis in Patients with Chronic Hepatitis C",American Association for the Study of Liver Diseases., 2007.

[4] Dakshata Panchal and Seema Shah," Artificial Intelligence Based Expert System For Hepatitis B Diagnosis "International Journal of Modeling and Optimization, Vol. 1, No. 4, October 2011

[5] GhumbreShashikantUttreshwar and A.A. Ghatol,"Hepatitis B Diagnosis Using Logical Inference and Self-Organizing Map",Journal of Computer Science 4 (12): 1042-1050, 2008

[6] Sarah Boslaugh,2012, "Statistics in a Nutshell, 2nd Edition", Publisher: O'Reilly Media, Inc.

[7] Evangelos Triantaphyllou ,Stuart H. Mann,1995, "Using theAnalyticHierarhy Processfordecisionmakinginengeneeringapplicationssom echallenges" Inter'l Journal of Industrial Engineering: Applications and Practice, Vol. 2, No. 1, pp. 35-44.

[8] Doraid Dalalah, Faris AL-Oqla, Mohammed Hayajneh, November 2010,"Application of the Analytic Hierarchy Process (AHP) in Multi-Criteria Analysis of the Selection of Cranes",JJMIE, Volume 4, Number 5, Pages 567 – 578

[9] Sterling RK, Lissen E, Clumeck N, et. al. "Development of a simple noninvasive index to predict significant fibrosis patients with HIV/HCV co-infection". Hepatology2006;43:1317-1325.