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Full Length Research Paper

A methodology to evaluate both internal and external environments of applied-scientific educational system used in strategic planning

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In the present work, we introduce a new model to evaluate an educational system, namely the applied-scientific system. This model provides us with a deep knowledge of different aspects of educational system including its organizational weakness and strength. Within our approach, making use of the production function and the calculated education area function, it is also possible to recognize different strategic aspects of an educational system and consequently improve it. This model, for the first time, provides the numerical values of both substantial and total factors of the educational system and, in a systematic manner, mathematically simulates the educated production function, the education area function, etc. Our proposed model could be extended to study an industrial system as well.

Key words: Mathematical model, educational system, strategic planning, internal and external environments.

INTRODUCTION

Common methodologies

Different approaches, including the matrix, deductive and comparative methods have been used to study the recognition stage of a system as well as its internal and environmental aspects, QSBM, the matrix model of internal and external factors, IEM, the combination matrix of weak and strength points, SWOT (acronym for strengths, weaknesses, opportunities, threats), the matrix of main strategies, GSM, Boston consulting group matrix, BCG, balance score card, BSC, analytic hierarchy process AHP, and the matrix of strategic situation evaluation, strategic position and action evaluation matrix, SPACE. All of the mentioned models are normally used in economics and technology and the purpose of all them is to recognize the exact situation of the system in order to choose the most capable strategy and thereby improve the system status and achieve the desired goals. The educational strategies have the same principles of engineering and management of knowledge and innovation development. Therefore, the designed system must have the ability to compare the previous and present statuses. In addition, it must be able to convert discontinues matrix methods used in the industry to evaluate the indices to construct functions applicable to the analysis of the educational systems (Alam et al., 2010a).

For educational purposes, because of their intrinsic complexity, in spite of different great ideas and investigations (Wells 1998; Napier, 1997; Steiner, 1997; Atlas 1988; Mizrahi and Mehrez, 2002; Leem and Oh, 2001; Verspoor, 1992; Cassidy, 1975; Milgram et al., 1999; Holder, 2007; Kölbl et al., 2008; Rovai, 2003; Kemp, 2000, 2008; Gallagher, 2002; Watkins, 2004; Pisel and Ritz, 2005; Borden and Deug, 2003; Chea, 2003; Chung, 2002; Clifford and Smitu, 1999; Cowin, 1994;

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Nomenclature: ECC, Education contribution coefficient; **ECA,** education content added; **ECI,** education climate index; **GE,** growth education; **T,** technoware; **O,** orgaware; **H,** humanware; **I,** infoware; **AHP,** analytic hierarchy process; **SFM,** subjective factor measure; **OFM,** objective fact or measure.

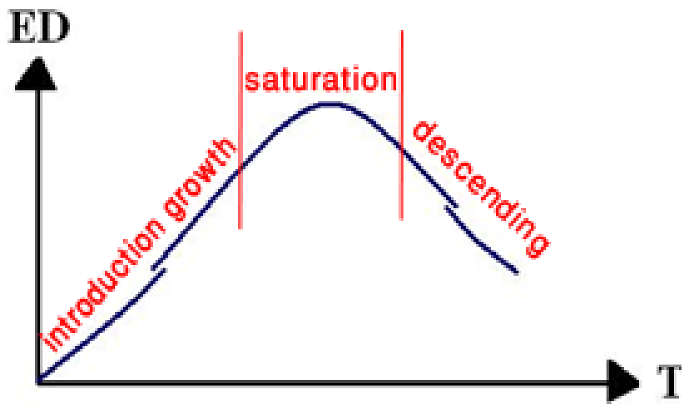

Figure 1. Growth figure of the applied-scientific education versus time.

Bennet and Douglase, 2001; Luce and weber 2003; Mac Beath, and Mac Glynn, 2002; Srikan and Dalrymple, 2002; Tovar and Edmundo, 2001; Unal, 2001; Worthen andSanders, 1997; Maryland, 2005; Richard and Robert 2003; Cheisa, 2000; Constance, 2005; Goh, 2004; Barnett, 2007), there remains a lot to do. To be more precise, we still feel the lack of transformative models with quantitative approaches in the annals of education.

Within our approach, however, instead of a qualitative treatment, we try to present a numerical model which mathematically simulates the educated production function, the education area function, etc. Our proposed model could be extended to study an industrial system as well.

LITERATURE REVIEW

The applied-scientific education as a function of technology

Knowledge is a product of awareness and the technology uses the awareness (Alam, 2009; Alam and Khalifa, 2009). On the other hand, education conveys and extends the awareness. Therefore, education could be considered as a function of knowledge while the knowledge itself is a function of awareness and technology (Alam et al., 2010b). As a result, the age cycle of technology is directly dependent on the age cycle of education that obeys an exponential growth (Alam, 2009b; Alam et al., 2010c). According to the aforementioned arguments, four periods are introduced for the educational system:

1. The introduction period: In the beginning of the procedure, some countries and scientific-research institutes begin to design and perform such a system.
2. The growth period: If the forerunners, that is, those who have introduced the system, succeed in overcoming the difficulties, other institutes and countries follow their footprints.
3. The saturation period: The intense need of countries and systems may lead to widespread development of an educational system.
4. The descending period: Finally, because of the advent of new or more capable systems, a system may gradually descend.

Since the progress affects the education and on the other hand, the level of education itself affects its growth rate, the growth of the education versus time could be considered to correspond to the exponential function $Y=(GE)^{Kt}$, with K and GE being the change rate and technological growth, respectively in Figure 1.

Recognition of indices and internal factors of applied-scientific educational system

In an analytical study, we consider the educational system as a process of production, as well as development of knowledge and technology. More precisely speaking, the system consists of four main major factors including technoware, orgaware, infoware and humanware. Each of these factors includes some subfactors and the latter themselves are considered as a composition of other engaged indices by the related experts. The engaged data are collected by sending the question forms to 50 experts as well as library research. The collected data are next brought into table forms to evaluate in strategic planning program. There exists 180 effective trivial internal factors some of which are represented in Table 1. The intermediate factors are introduced in Figure 2.

Effective environmental factors within the applied-scientific educational system

222 environmental subfactors affecting the educational system were included the question forms which 112 people answered. Within the form, there was 12 intermediate level each containing 4 general classifications. As suggested by Alam (2011), each level included both quantitative and qualitative sections who appropriate weight were take into account. 12 tables were included to evaluate the numerical data. However, as we intend to give a new model of evaluation, all the tables were not used.

Our approach, not only includes all factors that enter previous classifications such as: Goumbez classification, but also introduces a new insight to the problem.

The 222 samples are included in the present research which can be divided into four main categories: the economical- financial, the social-cultural, the political-

Table 1. A typical table to compare and determine internal indices.

Analysis of (Weakness ↓ ↑ Strength)	The present value of the factor 0 – 10	The impact of each factor system elements (weights)					The main factors of system		Sub H,O,…
	u_i		O	I	T	H		Sub (sub factors)	
			W_{i4k}	W_{i3k}	W_{i2k}	W_{i1k}	i / j		
							1 2 . . n	Level of ability strictness and being on time Eagerness to gain experience	
							1 2 3 4 . . m	Level in working with tools Level in installation Level of maintenance reparing Level of simulating	
							1 2 3 . . p	Power to absorb experts Power to motivate Power of given facilities	Motivation and absorption
				100	100	100	. . .		. . k
	$H_1 = \sum_{i=1}^{n+m+p} \frac{U_i}{n}$	$\beta_{H_1} = \sum_{i=1}^{n+m+p} \frac{U_i W_i}{100(n+m+p)}$							
↓ ↑	Ui		O	I	T	H	The main factors of system / Sub(sub factors)		Sub O_1
			W_{i4k}	W_{i3k}	W_{i2k}	W_{i1k}	i / j		O_{1k}
							1 2 . . n		K_1
			100	100	100	100			K_2 . .
	O_1 =	B_1 =							

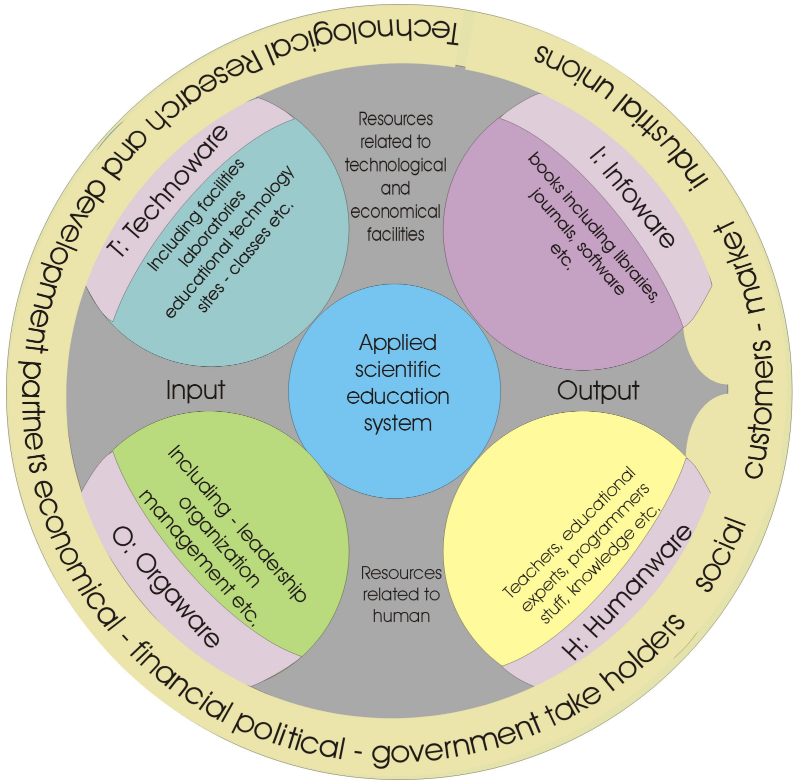

Figure 2. Environmental factors and indices affecting the applied-scientific educational system.

governmental and technological, research and development. In order to investigate the effects of each factor, we have considered each main environmental factor M_i composed of two sub-factors, that is, the objective factor measure OFM_i and the subjective factor measure SFM_i. Table 2 gives an example of such classification in the case of executive techniques.

RESEARCH METHODOLOGY

The assumptions and method of analysis

If we represent the major constituent factors of the educational system by $x_1, x_2, ..., x_n$ and the major environmental factors which affect the system by $z_1, z_2, ..., z_n$, the function $ECC = f(x_1, x_2, ..., x_n)$, after education contribution coefficient, and $y = g(z_1, z_2, ..., z_n)$ then represent the relation of factors in the internal function of the system and the relation of constituent factors and the environmental ones, respectively. In other words, the function y shows the impact of environmental factors on the system internal factors. Therefore, a function $h(ECC, Y) = [f(x_1, x_2, ..., x_n), g(z_1, z_2, ..., z_p)]$ could be defined such that it represents the time dependence of each factor on the other internal or environmental ones. The change in each parameter is shown by:

$$\frac{\partial x_i}{\partial t} = h_{ij}(x_1, x_2, ..., x_n, z_1, z_2, ..., z_p) \tag{1}$$

where $i = 1, 2, ..., n$ denotes the number major factors of the system, $j = 1, 2, ..., p$ is the number of effective environmental factors which affect x_i and the function h_{ij} shows how x_i depends on both internal and environmental factors, in Figure 7.

If the introduced parameters are determined, the educational system could be studied within a mathematical model and the increase in ECC could be calculated. It is also of great importance to plan in a way that maximum positive changes occur of the characteristics of the variables including the resource to x_i s. We try to maximize the function through minimizing the limitations of function. These limitations represent the variation of the characteristics of the variables including the resource limitations and the mutual effects of the environment and the system. Let us now consider the model for the applied – scientific system.

The function $ECC = f(x_1, x_2, ..., x_n)$

As the applied–scientific education obeys the exponential distribution, the Cobb-Douglas function could be considered as a

Table 2. A typical table to compare and determine evolution sub main external indices.

↓ ↑	U_i	W_i	O	I	T	H	i / j	**Technological and development factors** **OFM_i / SFM_i I = 1, 2, 3,…**	k
							1	Number of national students in different branches of science and technology.	(OFM_P) (RFD)
							2	Current costs and investigation fees of research and development in education.	
							3	Financial resources of R & D.	
							4 . . .	Number of registered inventions.	
							1	Level of importance and social level of technologists.	(SFM_P) (RFD)
							2	The way changes occur.	
							3 . . .	Flexibility of educational headlines.	
OFM_P = SFM_P =		α_p β_p	O	I	T	H	i / j	The value and the weight of the index.	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮

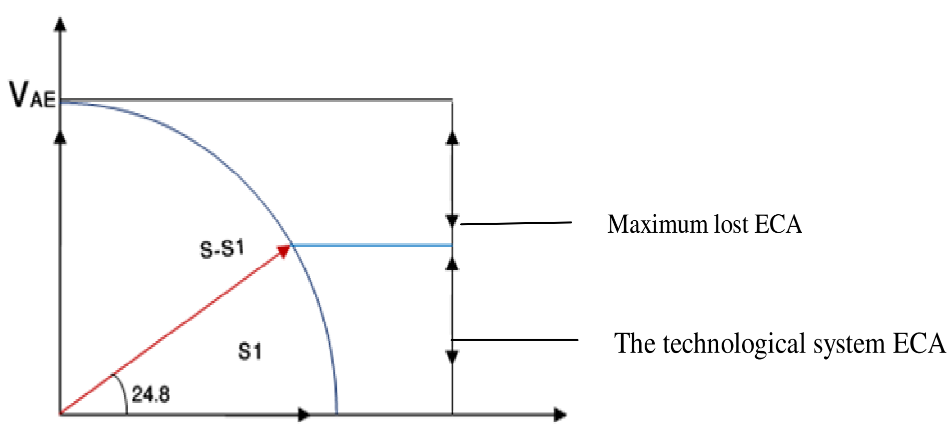

Figure 7. The gained and lost added education due to both internal and environmental factors.

suitable choice for our purpose, that is, the applied-scientific education system and the corresponding ECC function could be defined as :

$$ECC = F(T,H,I,O) = T^{\beta_T}.H^{\beta_H}.I^{\beta_I}.O^{\beta_O} \qquad (2)$$

Where T,H,I,O represent the major factors of the system and $\beta_O, \beta_I, \beta_H, \beta_T$ are the corresponding weights which are calculated through corresponding calculations of the eigenvectors of superiority function within the Analytic Hierarchy Process (AHP) method. The positive definite value of the function ECC is always less than or in its maximum case equal to unity. The nearer the value is to unity, the more efficient the system is. No production occurs when even one of these four factors is absent. The

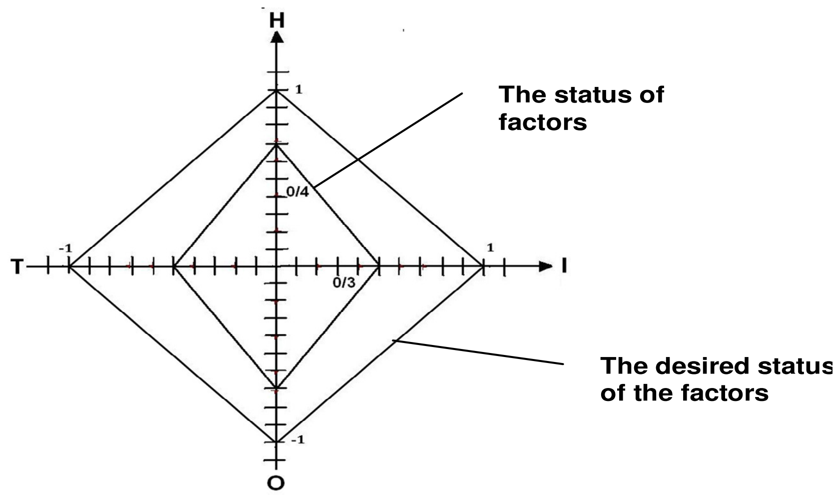

Figure 5. The total situation of the applied-scientific education.

parameter β shows the percentage of increase in ECC function when one factor has an increase of 1% and the others remain constant in Figure 5. Therefore, if $\beta = \beta_O + \beta_I + \beta_H + \beta_T = 1$, the efficiency is constant and is ascending if $\beta > 1$ and is descending if $\beta < 1$. As a result, one can write:

$$\frac{d(ECC)}{ECC} = \beta_T \frac{dT}{T} + \beta_H \frac{dh}{h} + \beta_I \frac{dI}{I} + \beta_O \frac{dO}{O} = \beta_T + \beta_H + \beta_O + \beta_I \quad (3)$$

It should be noted that in Equation 2, using the superiority matrix, we have considered the case of constant efficiency. Although each of the separate factors T, H, I and O shows the situation of the system, more complete analysis of the system is possible making use of the concept of ECC function.

The function $ECI = g(z_1, z_2, ..., z_m)$ (Education climate index)

This function is also composed of different indices which consist of two quantitative, OFM_i, and qualitative, SFM_i, parts for each environmental factor M_i with corresponding weights of α_i and β_i respectively. The Sherif-Sunderjohn model, with some changes and modifications, forms the skeleton of this model. We give a table of values of OFM_i and SFM_i for the executive section. We have n tables of main factors each of which consist of m quantitative and p qualitative factors. Therefore a more general index M_i could be introduced such that:

$$M_i = \alpha_i OFM_i + \beta_i SFM_i \quad (4)$$

Combining the main environmental factors we could now introduce the function y which is the total index of all these factors:

$$ECI \equiv y = \sum_{i=1}^{i=n} \frac{\beta_{Mi} M_i}{n} = \frac{\sum_{i=1}^{n} \beta_{Mi}(\alpha_i OFM_i + \beta_i SFM_i)}{n} = \alpha OFM + \beta SFM \quad (5)$$

With β_{Mi}, which is calculated using the method of AHP, showing the impact of each environmental factor. Naturally, the nearer the factors OFM_i and SFM_i are to unity, a more capable system exists and approaching this factor to unity indicates the deficiency of the system.

A mathematical methodology to evaluate the educational system

To complete the model we now introduce the function ECA which includes all indices and shows the total added education:

$$ECA = y.ECC.V_{AE} \quad (6)$$

Where in the aforementioned relation, V_{AE} is the current added value per production unit of education system and the coefficient y is the impact factor of external factors. V_{AE} is therefore the difference of the values of the system output and input in an educational period, that is,

$$V_{AE} = P_{WBi} - P_{WCi} \quad (7)$$

Where: $C_i = \sum_{L=1}^{k} \sum_{j=1}^{n} C_{ijL}$

With the cost j being spent on sections i and k in the year L within the educational period. C_i is the monetary equivalent of the educational costs in section i, with $i = 1, 2, ..., R$, and j, with $j = 1, 2, ..., m$ being the number of different factors engaged

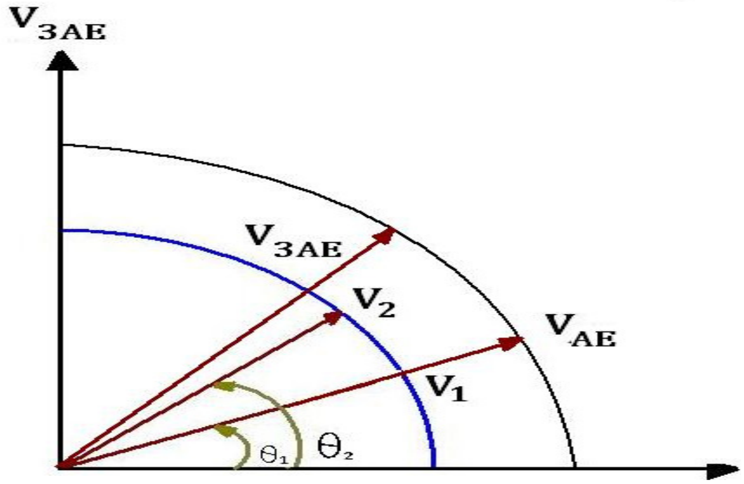

Figure 3. The education surface function versus constant or varying added value.

to transform the input to output. $B_i = \sum_{L=1}^{k} \sum_{j=1}^{n} B_{ijL}$ is the transformation relation which transforms all incomes to monetary equivalent with j being the number of factors of profit.

In summary, the total index, that is, the ECA function, could be written in the following form:

$$ECA=[\alpha(OFM)+\beta(SFM)](T^{\beta_T}, I^{\beta_I}, H^{\beta_H}, O^{\beta_O})(P_{WBi}-P_{WCi}) \qquad (8)$$

Analysis of the system using our methodology

We now try to analyze the model through analyzing the ECA and ECC functions. To give an example, let us now analyze the lost national or international opportunities within the applied–scientific system of Iran in comparison with other countries. According to Equation 6, we have:

$$ECC = \frac{ECA}{y.V_{AE}}$$

On the other hand, since $0 \le ECC \le 1$ we introduce a variable θ such that:

$ECC = \sin\theta$ or equivalently $\theta = \arcsin(ECC)$.

And as a result, we may now write:

$$x = V_{AE}\cos\theta$$
$$y = V_{AE}\sin\theta$$

It is also quite clear that since

$$r = \sqrt{x^2 + y^2} = \sqrt{V^2{}_{AE}\cos^2\theta + V^2{}_{AE}\sin^2\theta} = V_{AE}$$

the following polar figures corresponding to the relation

$$\theta = \arcsin(ECC)$$
$$r = V_{AE}$$

could be plotted according to Figure 3.

This figure shows the larger V_{AE} or θ is, the larger added education area exists. The point $\theta = \frac{\pi}{2}$ is a good criterion to calculate the maximum lost ECA, Figure 4.

Moreover, assuming a constant or known value of V_{AE}, the added education areas could be calculated making use of the following simple relation:

$$S_1 = \int_0^{\theta_1}\int_0^{V_{AE}} r dr d\theta = \frac{1}{2}V_{AE}^2\theta \qquad (9)$$

In addition, the maximum value of the education area is:

$$S_{\max} = S_1 = \int_0^{\frac{\pi}{2}}\int_0^{V_{AE}} r dr d\theta = \frac{\pi}{4}V_{AE}^2 \approx 0.8V_{AE}^2 \qquad (10)$$

Furthermore, if we plot the factors O, I, H, T it is possible to make a comparison among different countries and thereby reform or improve the present condition of the system.

The used executive techniques

Within every system aimed for strategic planning there exists a crucial role for the way of the evaluation of both internal and external factors and it is highly important that we avoid the unnecessary complexity in all stages of analysis. We have tried to simplify the approach using tables like Tables 1 and 2 which give the normalized numerical values. Furthermore, the level of confidence to such data has been elevated making use of complementary methods such as the method of AHP.

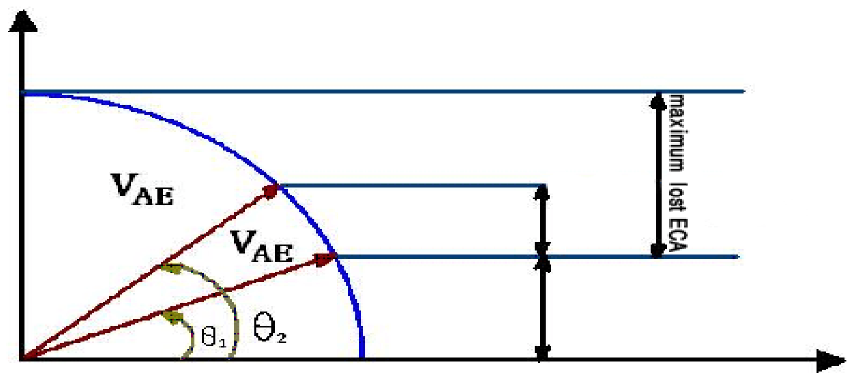

Figure 4. Maximum lost ECA/ the lost or gained education for constant V_{AE}.

In the previous table, the first column covers the sub-factors of the kth factor in different parts including the economical factors, etc. In each row, the experts inter the weight of each factor that is a number in the range of 0 to 10. Finally, the normalized average value u_k and the average weight w_k inter the mathematical methodology. To speak in more details, w_{ijk} is the relative importance or the standard weight of the ith factor to the jth factor, with j being, in the kth group. In determining the parameter w_{ijk}, both the present status of the ith factor and its relative importance are definitely included and thereby the analysis of the model is possible. Comparing the u_k and w_k 's, the advantages and disadvantages of the system are made known to the managers. On the other hand, the mathematical analysis provides the relative importance of each factor within the system and evaluates the present status of the system through considering the effects of all parameters. In Tables 1 and 2 the way we value internal and external factors are illustrated respectively. Tables 3, 4, 5 and 6 determine the level determining tables and the higher the number of the used systems is, the higher the corresponding value will be. Numbers 10 and 0 are given to the best and worst international situations in each column matrix element, respectively.

These matrices are then combined together with appropriate weights and normalized thereafter leading to one number for each matrix.

The obtained numbers T_1, H_1, O_1, I_1 and T_2, H_2, O_2, I_2 are finally combined together with appropriate weights and give the final T, H, O, I parameters. Theses matrices compare the main factors of the environment with those of the educational system, determine the priorities using the method of AHP and finally calculate the weight of each factor, that is, $\beta_O, \beta_T, \beta_H, \beta_I, \beta_{M_i}$. The corresponding superiority matrix is dependent on the opinions of experts whose given qualitative opinion is brought into a quantitative form through a table similar to Table 7. Table 8 is the superiority function of the applied-scientific educational system that is formed by means of the AHP method and each pair of factors are calculated within. For example, number 3 in Table 8 indicates the weak superiority of the management factor to human ware. To determine the priorities of mutual impacts within the applied-scientific educational system, as well as promotion of confidence level of obtained weights, we make use of the AHP method to calculate the weights, that is, $\beta_O, \beta_T, \beta_H, \beta_I$ and β_{M_i}. In the case of qualitative subjects, these weights are obtained from doublet comparisons, that is, through calculation of the corresponding eigenfunctions of superiority matrices. Finally, combination of weights gives the possible options and the criterion for making a decision is Table 8 which allows us to make a comparison among different engaged factors. Number 3, for example, shows the weakness of management relative to human ware. More generally speaking, numbers show the relative importance of factors to each other. To give another example, we can say that since $a_{35} = 5$ indicates the higher importance of human ware to information. $\beta_O, \beta_T, \beta_H, \beta_I$ are calculated from Table 8 through calculation of corresponding eigenvectors. Finally, the impact of environmental factors on the factors of system, that is, β_{M_i} s, are calculated using the tree network. To do this, Tables 9 to 12 must be formed and the statistical averaging among different factors must be made.

α_{ij} 's, that are obtained from the eigenvectors of the comparison, show the result of the comparison of each environmental factor with that of the educational system. β_{M_i} 's are aligned from the minimum value to the maximum one and the value denotes the effect of the environmental factors obtained from the OFM_i and SFM_i Tables 15 and 17.

Table 13 is almost the final step in the sense that the process of determining the weights and the priority of factors comes from it:

$$\sum_{j=1}^{4} \beta_j \sum_{i=1}^{4} \alpha_{ij} = \beta_H \begin{bmatrix} \alpha_{11} \\ \alpha_{21} \\ \alpha_{31} \\ \alpha_{41} \end{bmatrix} + \beta_O \begin{bmatrix} \alpha_{12} \\ \alpha_{22} \\ \alpha_{32} \\ \alpha_{42} \end{bmatrix} + \beta_T \begin{bmatrix} \alpha_{13} \\ \alpha_{23} \\ \alpha_{33} \\ \alpha_{43} \end{bmatrix} + \beta_I \begin{bmatrix} \alpha_{14} \\ \alpha_{24} \\ \alpha_{34} \\ \alpha_{44} \end{bmatrix} = \begin{bmatrix} \beta_{M1} \\ \beta_{M2} \\ \beta_{M3} \\ \beta_{M4} \end{bmatrix}$$

Evaluation of the methodology

With the help of many colleagues, we have tried to study the model in the case of technological education system. The results of given forms have been included in Table 4. Each internal factor is classified into five groups. The factor of information and

Table 3. Determination of the technological knowledge of the system.

Criterion	Level						
	Introductory	Explainer	Determiner	User	Expansion	Generalization	Evaluation
Availability							
Number of communications							
Being update							
Exchangeability							
U i							
W j							

Table 4. Determination of the level of the educational facilities and equipments.

Criterion	Level						
	Combination	Computer	Automatic	Specialized technical	General technical	Mechanical	Manual
Work shops							
Laboratories							
Information system							
Accounting system							
Educational technology							
Research and development							
U i							
W j							
Work shops							
Laboratories							

Table 5. Determination of the human abilities of the system.

Criterion	Level				
	Combination	Improvement	Simulation	Repair and maintenance	Installation of machineries
Eager to progress					
Creativity					
Motivation					
Team work					
Level of expertness					
Risk-taking					
U i					
W j					

technological knowledge Table 14, for example, has been classified in terms of the level of information, accessibility, level of relevance, amount of information and the process of information increase. The consequent results are reported in Table 1. similarly, the sub-factors of environmental factors are classified into two main qualitative and quantitative categories including the economical, social, demographical, cultural, political, technological, research and developmental, financial, international atmosphere factors, etc.

The analysis of the obtained results needs a comprehensive study within the framework of a strategic planning. The obtained numerical values indicate that the BCC value is less than the relatively appropriate situation. The corresponding figure shows that in order to balance the situation of the system, that is, the relation between the constituent factors, the human factor must be given the first and the most attention as in Table 16.

The factors of planning and management are in the next level of

Table 6. Determination of the management and organization level of the system.

Criterion	Level						
	Leadership	**Success**	**Stabilization**	**Supportiveness**	**Braveness**	**Dependence**	**Effort**
Independency							
Engagement							
Creativity							
Forecasting							
Leadership							
U i							
W j							

Table 7. Transformation of qualitative judgments to quantitative ones.

Numerical value	Interpretation
1	Row is as important or good as column.
3	Row is a little better or more important than column.
5	Row is better or more important than the column.
7	Row is much better or more important.
9	Row is too better or more important than in the extreme limit.
2, 4, 6, 8	The situation is between the situation of the neighbor odd numbers.

Table 8. Comparison between factors of education.

The main factors of the system	Technology (T)	Organizing (O)	Human ware (H)	Information (I)
Technology (T)	**1**			
Organizing (O)		**1**	**3**	
Human ware (H)		**1/3**	**1**	**5**
Information (I)				**1**

Table 9. The external factors in comparison with the factor of organizing.

Orga war (O)	Economical	Social-cultural	Political-governmental	Technological-developmental
Economical	1			
Social-cultural		1		
Political-government			1	
Technological- developmental				1

$$VO = \begin{bmatrix} \alpha_{12} \\ \alpha_{22} \\ \alpha_{32} \\ \alpha_{42} \end{bmatrix}$$

Table 10. The external factors in comparison with the human factor.

The main factors of the system	Technology (T)	Organizing (O)	Human ware (H)	Information (I)
Technology (T)	1			
Organizing (O)		1	3	
Human ware (H)		1/3	1	5

importance to obtain reform the status of the system. Therefore, the total index of technological education system of Iran is calculated to be $Y = 0.451$. The gap between the present status of the system and its desired level naturally leads to its operation. This is more obvious when the effect of the latter is combined with the total factor of education system. The final decrease in the added value is about 80%. Therefore, promotion of the added value solely is not sufficient and the factors of educational space and components

Table 11. The external factors in comparison with factor of technological tools.

Techno war (T)	Economical	Social	Political-governmental	Technological
Economical	1			
Social-cultural		1		
Political-government			1	
Technological				1

$$VT = \begin{bmatrix} \alpha_{13} \\ \alpha_{23} \\ \alpha_{33} \\ \alpha_{43} \end{bmatrix}$$

Table 12. The external factors in comparison with the information and knowledge factor.

Infor war (I)	Economical	Social	Political-governmental	Technological
Economical	**1**			
Social-cultural		**1**		
Political-government			**1**	
Technological-research				1

$$VI = \begin{bmatrix} \alpha_{14} \\ \alpha_{24} \\ \alpha_{34} \\ \alpha_{44} \end{bmatrix}$$

Table 15. A typical table of determination of sub main environmental factors' status (Mi).

KTH factor	Sub main environmental factors	Normal value	Intensity of threat	Intensity of opportunity	Intensity of collation	Status analysis
OFM_1	The value of the qualitative index indicates the economical-social status.	0.42	5	-	2	Damage-receiving
SFM_1	The value of the qualitative index indicates the economical-social status.	0.48	1	4	2	Damage-receiving
M_1	The mixed index indicating the economical-social status of the system	0.45	3	-	2	Damage-receiving
OFM_2	Quantitative value of the environmental support of the system.	0.48	3		2	Damage-receiving
SFM_2	Qualitative value of the total index representing the supportive status of the system.	0.49	3		2	Damage-receiving
M_2	Analysis: totally speaking, the situation is relatively poor. This poorness is mainly because of weakness in attracting mutual relations rather than because of financial supports such as facilities. Also, new occupations and techniques are very late included within the system.	0.485	3		2	Damage-receiving
OFM_3	The quantitative value of the political factors affecting the quality of the decision of the system.	0.4	7		4	Damage-receiving
SFM_3	The quantitative value of the political factors.	0.42	6		3	Damage-receiving
M_3	The total value of the political factor. The obtained value shows that the managers are not eager to use other sources to achieve the goals of the applied-scientific educational system.	0.41	7		4	Damage-receiving

Table 5. Contd.

OFM_4	The quantitative value of the cultural demographical factor of the system.	0.52		3	2	Ready
SFM_4	The quantitative value of the cultural - demographical factor of the system.	0.55		4	3	Ready
M_4	The total index of the cultural - demographical factor of the system. Analysis: Besides the lack of proper programming, the rapid rate of population increase within the recent years has lead to a abusing the facilities. Nevertheless, the present status as well as the future decrease in population increase might lead to an acceptable situation within the 20 years.	0.535		4	3	Ready
.OFM_{10}	The qualitative value of the scientific-technological factor of the system.	0.48	5		2	Damage-receiving
SFM_{10}	The quantitative value of the scientific-technological factor of the system.	0.36	5		3	Damage-receiving
M_{10}	The total value of the scientific-technological factor of the system.	0.42	6		3	Damage-receiving

Table 17. Different environmental factors and the effective environmental factor.

OFM1 = 0.42	$\alpha_1 = \frac{1}{2}$	SFM1 = 0.48	$\beta_1 = \frac{1}{2}$	M1 = 0.45
OFM2 = 0.48	$\alpha_2 = \frac{1}{2}$	SFM2 = 0.49	$\beta_2 = \frac{1}{2}$	M2 = 0.485
OFM3 = 0.4	$\alpha_3 = \frac{1}{2}$	SFM3 = 0.42	$\beta_3 = \frac{1}{2}$	M3 = 0.41
....	....	....	....	....
OFM10 = 0.46	$\alpha_{10} = \frac{1}{2}$	SFM10 = 0.32	$\beta_{10} = \frac{1}{2}$	M10 = 0.638
$OF\,M = \frac{\sum_{i=1}^{10} OF\,M_i}{10} = 0.452$		$SF\,M = \frac{\sum_{i=1}^{10} SF\,M_i}{10} = 0.45$		Y = 0.451

Table 13. Comparison matrix of external and internal main factors.

Environmental factors	Educational factors			
	Humane ware (H)	Orga ware (O)	Techno ware (T)	Infor ware (I)
Economical	α_{14}	α_{13}	α_{12}	α_{11}
Social-cultural	α_{24}	α_{23}	α_{22}	α_{21}
Political-government	α_{34}	α_{33}	α_{32}	α_{31}
Technological	α_{44}	α_{43}	α_{42}	α_{41}

impact play a significant role in the estimation of the effect of educational system on both individuals and society (Figure 6).

Calculation of ECA and the added education diagram

According to the obtained values $Y = 0.451$ and $ECC = 0.42$, the added education of technological education system is obtained in terms of its added value. It should be once emphasized that the current value of the added value has assumed to be constant.

The effect of technological education in the increase of education level in units of graduated students is given by the relation:

$$S_1 = \int_0^{\frac{24.8}{180}\pi} \int_0^{V_{AE}} r dr d\theta = 0.22 V_{AE}^2$$

Table 14. A typical table for evaluation of information and knowledge sub factors (I).

Intensity of collation	The intensity of weakness / strength	Summary of analysis	Normal score	The status of the information and knowledge sub main factors	Code Sub main Factors
4 Read 6 Damage-receiving	5 8	In the primary levels of knowledge, the system possesses a relatively good condition. There exist instructors who teach knowledge and skill. At higher levels, this factor decreases because of the technological level of the country and developmental strategies for new fields become less possible.	0.457	The level of the used knowledge.	L I
5 Damage-receiving	7	The system lacks a harmonic accessibility to the information and only a disperse accessibility exists among the teachers and instructors.	0.421	The accessibility of the used knowledge and information.	CI
4	6	As the main decision makers and educational programmers are not completely familiar with the industries as well as the needed occupations, this factor is poor, too.	0.398	The level of relevance of the used knowledge and information with the needed skills.	RI
7 Damage-receiving Dangerous	9	In comparison with the rapid development of technology, the status of the system is poor. Absence of management information system, poor relation with the national industries and international scientific systems are of the main reasons of this poor level.	0.412 0.312	The status of the information amount the process of increase in the amount of information.	VI
			;	The total index due to the factor of information and knowledge in the technological education process.	I
I= 0.4	β_I= 0.220				

Table 16. The ingredients of technological education/ situation index/ impact of each factor.

Impact of each factor	Situation index	The ingredients of technological education
$\beta_T = 0.26$	T=0.45	Techno ware
$\beta_H = 0.25$	H=0.51	Human ware
$\beta_O = 0.25$	O=0.45	Orga ware
$\beta_I = 0.24$	I=0.4	Infor ware
$ECC = T^{\beta_T} . H^{\beta_H} . O^{\beta_O} . I^{\beta_I} = 0.459$		

Which shows that the level of efficiency is 28% lower than the relative efficiency and the efficiency of the system when the correlation of the factors is taken into account is:

$$\frac{S_1}{S} = \frac{0.22V_{AE}^2}{0.8V_{AE}^2} = 0.28 = 28\%$$

If we now enter the problem the environmental space factor (y) as the third dimension of the model, the volume of the added education in the case of constant V_{AE} is obtained as:

$$S_1 = \int_0^{\frac{24.8}{180}\pi} \int_0^{V_{AE}} \int_0^{0.451} yrdydrd\theta = \int_0^{0.33} \int_0^{V_{AE}} 0.102rdrd\theta = 0.022V_{AE}^2$$

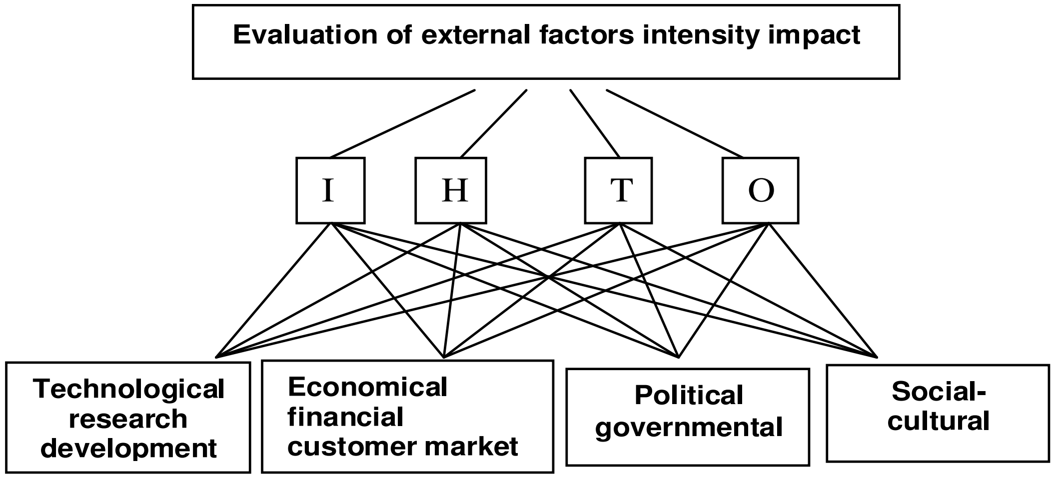

Figure 6. Technological tree network to evaluate the intensity impact of external factors.

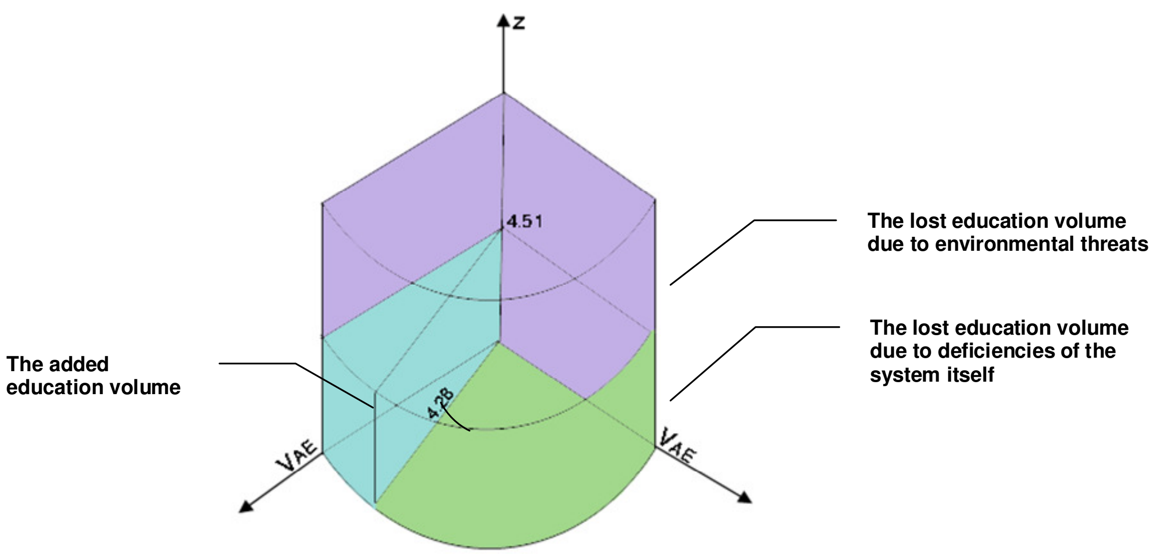

Figure 8. The added education (knowledge) in comparison with the lost education for constant V_{AE}.

Figure 8 shows the added education (knowledge) in comparison with the lost education (knowledge) when the variations of V_{AE} are absent.

RESULTS AND DISCUSSION

The advantage of our model is its potential to convert different acceptances and components of the model into a mathematical formulation which is convertible to software which could be extended to a fuzzy neural network. We hope to extend the present study to the latter.

Conclusions

Our presented model, not only gives the possibility of recognition of failures, opportunities, threats and advantages of the system, but also clarifies the priority of the system factors and their importance in comparison with the environmental factors and thereby enables the managers to develop the desired strategies. Actually, the managers concentrate system as efficiently as possible.

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