Human Resource Productivity Measurement And a Problem Solving Algorithm

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Abstract

This paper looks into the Human Resource Productivity from a new prospective, embracing the following features:

-Introduction of the main elements of Human Resource (personnel) productivity,

-Illustration of the Human Resource Productivity in the form of a system with three inputs (Will, Can and May) and one output as Human Resource Productivity,

-Presentation of the Human Resource Productivity in a mathematical model for its measurement,

-Proposal of an algorithm for promotion of Human Resource Productivity,

-Introduction of a three-phase-problem solving algorithm (recognizing the problem, identifying the cause, giving the solution) based on the stated Human Resource Productivity model,

-Presenting methodology and the application of the model and the mentioned algorithm in the framework of a Measurement Decision Support System for the rise (promotion) of Human Resource Productivity.

Keywords

Human Resource Productivity, measurement, Fuzzy logic, Problem solving, Human Resources Management, Decision Support System

Introduction

The concept of the Productivity can be summarized as attaining organizational goals together with proficiency, efficiency, and quality. Accordingly one of the most essential topics in the management sciences and, at the same time, one of the most important duties of the managers, is the promotion of productivity in industrial and services organizations (Hinterhuber,1996).

Human, as the axis and target of productivity, plays the main and key role in this aspect. For the very reason it can be claimed that Human Resource Productivity (HRP) is one of the most crucial elements of productivity in an organization (Bartsch and Afrazeh, 2000).

Considering the importance of the Human in Organization and his role in rise of productivity, it is necessary to:

1-recognize the factors affecting HRP,

2-formulize the extend of the effective factors by the appropriate mathematical means; Relationship to HRP and it provides the possibility of calculation of HRP, practicality in the organization,

3-Identify the existing situation through appropriate problem-solving algorithm, provides the means for recognizing the causes as well as finding out the appropriate strategy to rise the

HRP in the organization.

Through out the paper we have tried to, as provide proper answers for the above mentioned items via presenting suitable model and algorithm, taking into consideration the methodology and application of the model and algorithm in the framework of a Decision Support System.

2-Main Factors in Human Resource productivity

Library research has shown that most scientists in management and productivity discipline as well as behavior sciences, in one way or the other, recognize two factors for the Human Resources productivity, namely *Will* and *Can* (Vroom, 1991, Bisami, 1995, Bartsch 1999, Rabins, 1993, Drumm, 1995, Poalti,1993).

Will reflect the human motivation, and *Can* deals with the professional, physical and spiritual abilities of human (Afrazeh, 1999).

Most of these scientists have maintained a higher role and regard for motivation in productivity compare to *Can*, and believe that people with positive motivation will strive to gain the necessary abilities to fulfill their jobs (Robins, 1993, Blanchard and Hersy, 1993)

Here this question is raised that whether or not other factor(s) together with the *Will* and *Can* could be presented to play the main role.

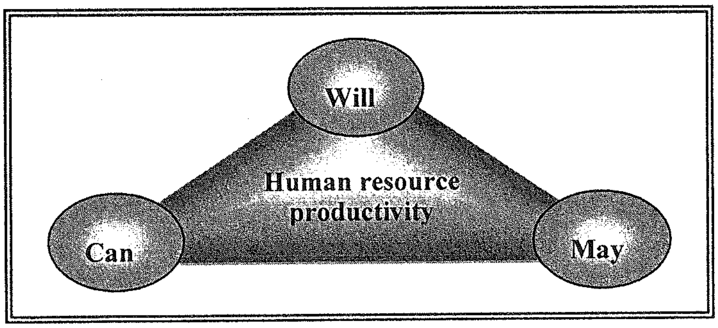

Figure 1 Dynamic interaction of three main elements of Human Resource productivity.

Keeping in mind the results of the library and field researches here we introduce this new factor as *May* (Afrazeh, 2001). This external factor is related to organization, through which the needed facilities should be provided. These three factors interactively have mutual effects on each other and their summation will build up productivity(figure 1).

The interrelation of these factors with HRP has been depicted in the form of the formula No.1 (Afrazeh, 2001).

$$P_{hr} = f(W, C, M) \qquad (1)$$

Formula 1: Human Resource productivity function

Which:

P_{hr}: stands for HRP,

W: Will,

C: Can,

M: May.

2-1-Definition and Concept regarding Will, Can and May

"Will" gives energy, creates motive will, and leads to decide for or against fulfilling a job. *Will* is a function of the value and remuneration system of an individual. On the basis of these two the individual decides whether to accomplish a job or not.

"Can" shows how the created energy should be utilized properly. It is related to physical

and spiritual ability, skill, experience, and general qualification of an individual.

"May" creates the necessary background and paves the way for benefiting from the provided energy. It is related to organizational and work surrounding factors such as working tools, technology, resources, organizational structure, methods, regulation and laws and so on.

These main components are known as the necessary *internal* (Will, Can) and *external* (May) factors. The former is related directly to the Human Resource and the latter to organization. The elements of this external factor should be supported by the organization and managers, keeping in mind that supporting the development of the internal factors (creating the necessary motive and abilities) are also among the important responsibilities of the organization.

3-Illustration of Human Resource productivity as a system with three inputs and single output

In figure.2, HRP as a system with *three main inputs* (*Will, Can* and *May*) and a *single output* (HRP) is illustrated. We must bear in mind that each one of the main inputs is the outcome of other agents, and these here as subsystems and sub processes with their own subsidiary inputs and outputs (Afrazeh, 2001).

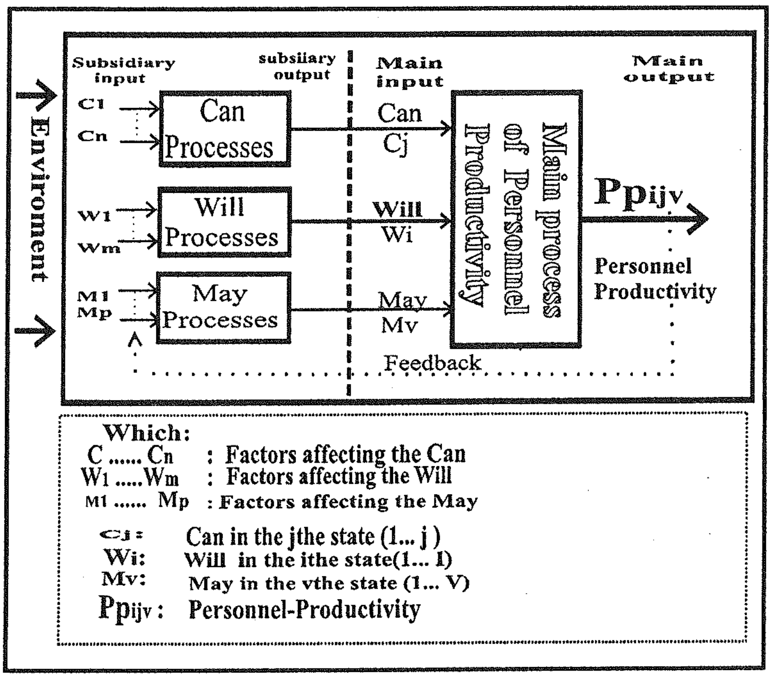

Figure 2 Human Resource productivity system with three main inputs and single output.

A clear cut border to these three main factors can not be distinguished.

We should decide on each case as which of the main factors are most affected by the respected subsidiary factors, so that to include those in the related groups, and/or by attributing the necessary weight to each, a proper distribution in the related groups is signified (Contingency-Situation Approach).

4-Mathematical presentation and calculation of human resource productivity

Measuring HRP is of great importance for managers in the organizations(Hinterhuber, 1996a). In the classical literature productivity is basically calculated via a special form of the general formula No. 2.

$$\text{productivity} = \frac{\text{ouput}}{\text{input}} \qquad (2)$$

Formula 2: General formula of Productivity

As an example one can refer to formula No. 3 on which the productivity is the outcome of employees work (amount of goods produced) to the number of the employees that produces the goods.

$$\text{Personnel productivity} = \frac{\text{Amount of the produced goods}}{\text{Number of the employee}} \qquad (3)$$

Formula 3: One of the classical formulas for calculating Human Resource productivity

Using such a classical formula one cannot measure HRP, observing the effective factors that have been proposed in this article. To tackle this problem we rely on the library searches and support of the field works which recapitulated and analyzed the results of more than 90 academic researches, and embraced 18000 employees of various services and industrial organization and also the especial purpose-built empirical researches which comprises 64 organization (Afrazeh, 2001). Finally the main and effective components of the HRP have been ascertained and confirmed as *Will, Can* and *May*. Also effective factors on each of these main components for the population under the study have been specified, here we will not discuss favourable factors for the main components of this study.

In summary, both library and empirical studies stress that the role of *Will* (*motivation*) is more crucial comparing to the other two components *(Can* and *May)* and the former acts as an accelerating agent for the other two.

Work for the mathematical presentation of the system as a mean to calculate the HRP base on the research findings was a necessary step that has been taken in the following manner.

$$\text{Productivity}=\text{Motivation} * \text{Competency} \qquad (4)$$

Formula 4: Human Resource productivity (Hersy and Blanchard 1993)

Inspiring from Victor Vroom mathematical formula (formula No. 4) ,where we take motivation as *Will* and competency as *Can* and by depending on our research findings and emphasizing on the third effective factor of HRP, namely *May*, we propose formula No. 5 for measuring productivity

$$Pp_{ijv} = W_i (C_j + M_v) \qquad (5)$$

Formula 5: Measuring Human Resource productivity (Afrazeh, 2001)

Herewith we call this model the *Will-Can-May* Productivity model. To test the credibility of the proposed formula (5) for the calculation of HRP and its meaningful relation with the result of classical formula (3) as well, we use real data from two organizations to calculate HRP.

In using formula No.4, for calculation of HRP, two general mathematical frameworks are possible:

- *Classical mathematics (Crisp): Discreet method*
- *Fuzzy mathematics (Soft): Fuzzy logic*

Evidences show that calculation via.fuzzy method has more strong points than discreet method, as:

-Qualitative issues could be better presented through linguistic variable, so Fuzzy method with its peculiar characteristics in calculation and presentation of such cases can act stronger

(Fazel Zarandi, 1998).

-Fuzzy logic benefiting *"if, then"* rule and Fuzzy rule base can better act in controlling states of such systems in various conditions (Zadeh, 1975).

Considering the strong points of Fuzzy approach ,through an example calculation and the different states of HRP is vividly illustrated.

4-1- Fuzzy method computation

At this stage we illustrate our model by solving an example via. fuzzy method, but before going through that we give some general explanation about fuzzy logic.

In fuzzy logic to show the value of a linguistic variable we use natural Language(Zadeh ,1975) such as low, high ,cold ,warm. This canonical form can be presented in the following general form:

"X is F"

Where $X=(x_1, \ldots, x_n)$

F= word, sentence

Each linguistic variable is constitute of the following pentaple (Taheri, 1996):

$$(X, T(x), U, G, M) \tag{6}$$

Formula 6: Elements of linguistic variable

Where:

X = name of variable,

T (x) = set of all terms related to the X,

U = universal set,

G = syntactic rule,

M = membership function

Now we are in a position to define our HRP input variable *(Will, Can, May)* in fuzzy logic parameters.

Here the variable *Will* for the three states of weak, medium and strong is defined as a linguistic variable.

X: the name of variable, here is *Will*, abbreviated as W

T(x): the set of all the terms related to various states, here is weak , medium and strong

U: universal set, in this example U = (0, 10)

G: as a rule it specifies the value of the membership for each "x". As an example for x = 0, W is weak.

μ (x): is a rule which specify for each term a membership function, for example

$\mu(\text{will}) = (X, \mu_{\text{will}(u)}, U \in (0,10))$

The membership function of this example is:

$$\mu_{weak}(\text{Will}) = \begin{cases} 0: & \text{for } \mu > 4 \\ 1: & \text{for } 0 < \mu < 2 \\ 0 < \mu < 1: & \text{for } 3 < \mu < 4 \end{cases}$$

With the same procedure, as for the other fuzzy terms (here weak, medium…) we can also define the elements of linguistic variable for *Will, Can* and *May* can be defined.

Table (1) Term/Range for Will, Can and May.

Term	Weak	Medium	Strong
Range	0 to 4	3 to 7	7 to 10

Figure. 5 depicts the fuzzy curve of these linguistic variable for this example.

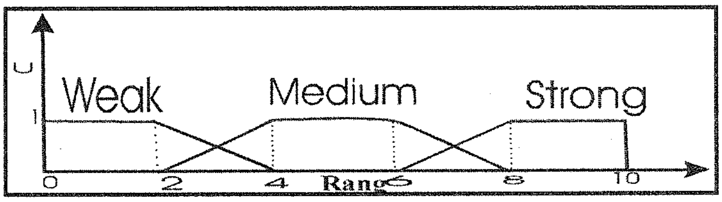

Figure 5- Fuzzy illustration of linguistic variable.

Now using formula no. 4, one can compute the HRP for the various states of our example as a system (figure 2) output. To continue first we randomly produce numbers to stimulate and produce all the conceivable states and by plugging them into the formula No. 4, we obtain the fuzzy values for HRP.

To show all the possible states of the model in a fuzzy computation we take advantage of existing fuzzy program (Sugeno and Ysukawa, 1993) which work with multiple inputs and single output.

The rule for such a multiple inputs and single output model is as follows:

Rule: if x_1 is A_1 and x_2 is A_2, ..., x_n is An then Y = Bi

x_i: input variable here *Will*, *Can*, *May*

Yi: output, here HRP

Bi, Ai, ….: Fuzzy term

Ri: is the i^{th} rule

The following formula is the Sugeno and Yasukawa (1993) proposal for a fuzzy computation of the multiple input system.

$$S(c) = \sum_{K=1}^{n} \sum_{i=1}^{r} .(\mu_{ik})^{m} (\| x_k - V_i \|^2 - | vi - x |^{-2}) \quad (7)$$

Formula 7: Sugeno and Yasukawa (1993) for fuzzy computation of the system with multi inputs and single output

Where:

n = number of data to be clustered

c = number of clusters

x_k = kth data, usually a vector

x = average of data , x_1, x_2, x_3,...x_n

Vi= vector expressing the center of the ith cluster

|| || = norm

μi_K =grade of Kth data belonging to the ith cluster

m = adjustable weight (usually m=1.5)

Figure 6 shows the structure of a HRP model using fuzzy computation formula of multiple input and single output (MISO) for this example.

This structure for our example gives all the possible states regarding the HRP on the basis of the following rule:

If $W = W_i$ and $C = C_j$ and $M = M_v$ then $Pp = Pp_{ijv}$

The structure not only gives the system status quo values but also simulate the desired situation through Fuzzy technique. Then by comparing the present with the desired situation we would plan to achieve our goals.

In the section for the application of the model the usage for this situation will become clearer. In line with that we propose a problem-solving algorithm for promotion of productivity.

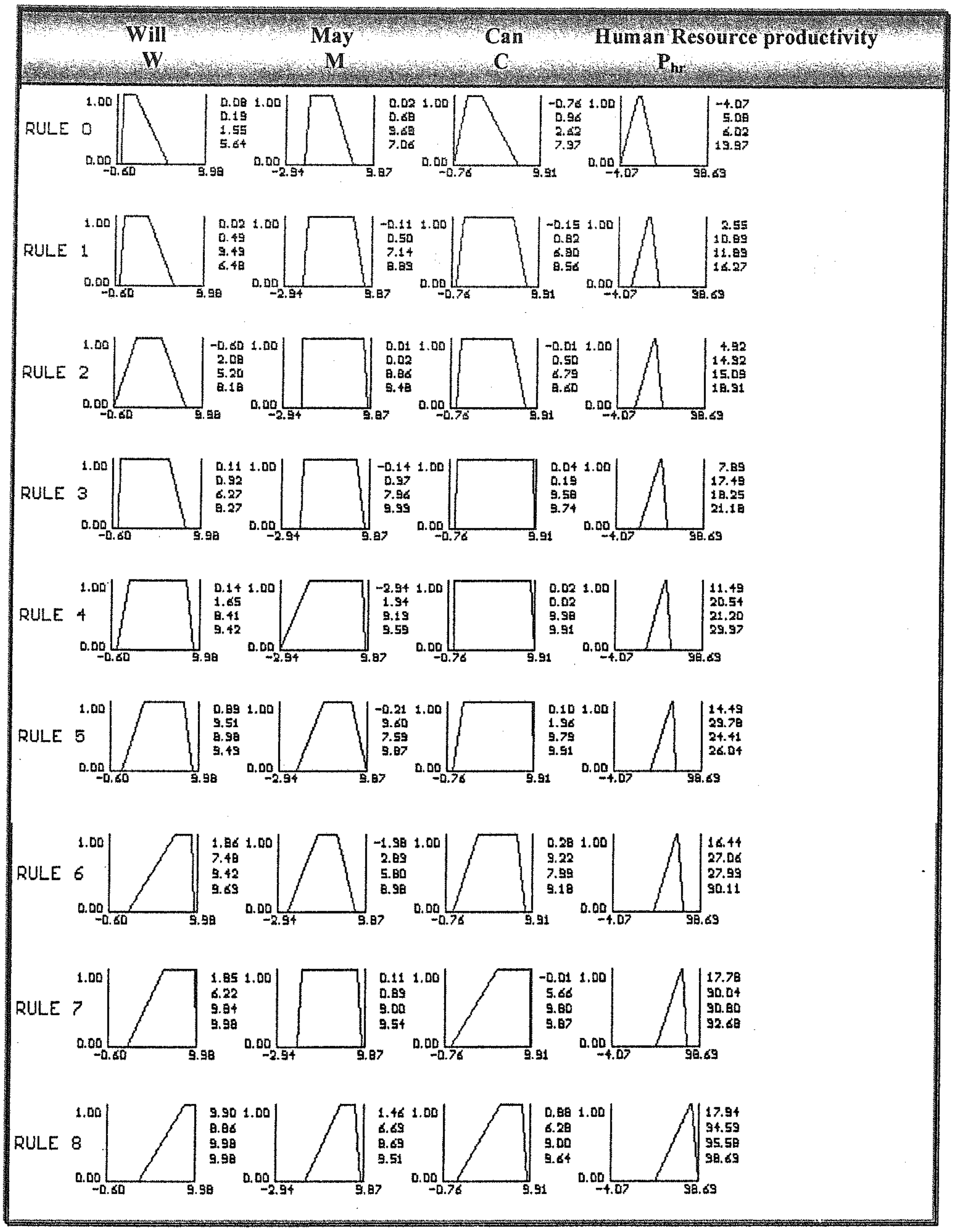

Figure 6- Illustration of Human Resource productivity as a fuzzy MISO model in this example.

5-Problem solving algorithm

There will always be gaps between the existing state and the desirable one for HRP owing to different reasons.

One of the duties of the organization authorities is to decrease the gap as far as they can. Therefore, we present a three–phase problem-solving algorithm for promotion of the HRP considering its main components, *Will, Can* and *May* as follows (Afrazeh, 2001):

Phase one:

Recognition of problems relating to *Will, Can* and *May*:

- *Will*: Personnel evades to do job
- *Can:* Personnel is unprofessional

- *May:* An individual or an object acts as a troublesome factor.

Phase two:

Recognition of the cause of the problem pertaining to:

Will: Internal and external factors cause discouragement (including, managers, remuneration system, evaluation system, type of work, etc.)

*Can:*Personal knowledge, capabilities, experiences, skill, physical abilities, mental abilities, etc.

May: Including organizational structure, rules and regulations, programs, leadership, work tool, authority, etc.

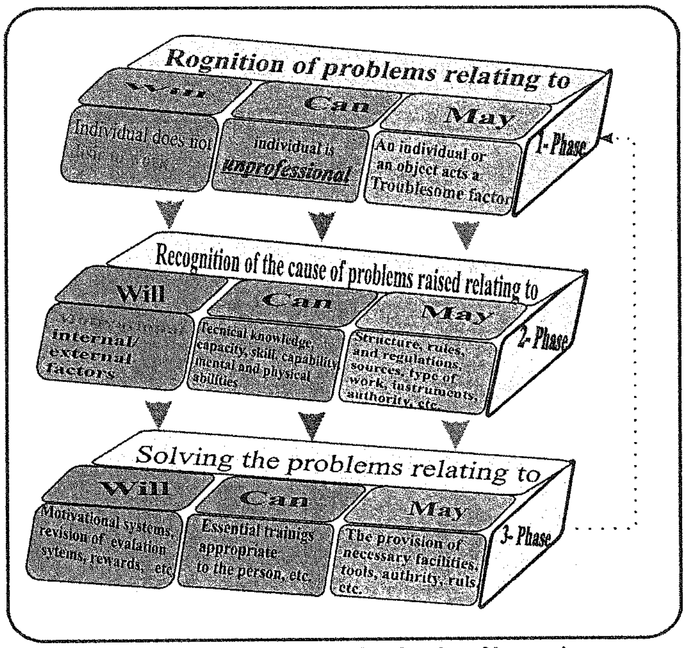

Figure 7- three phase problem solving algorithm for the rise of human's resources productivity.

Phase three:

Solving the problem regarding:

Will: Use of motivational ways considering the obtained results and creation of values (*motivation*)

Can: Training, development of capacities and capabilities, occupations appropriate to the capacities and interests

May: Provision of a good and appropriate situation by the organization, via procedures, tool, authority, sources, etc.

Figure 7 illustrates this algorithm schematically.

6-Application of the presented model and algorithm

In order to test and apply practically the presented model and algorithm, a support system for measuring as well as rise of HRP has been designed (Afrazeh, Bartsch, Najafi 2004). Here without going into detail of the system designing technique (figure no. 8), the functioning methodology of the system with regard to the stated concepts in this paper is dealt with in general, as a mean to show the applicability of the presented model and algorithm.

Effective factors on the three main elements of HRP (*Will, Can, May)* which have been collected from recapitulation of the results of 100 university researches (covering 20000 personnel and 145 different Iranian organizations) through 117 questions, have been classified in the three groups of *Will, Can and May* to be presented in the framework of the problem-solving algorithm of this paper according to the following order:

1-Determining the existing situation: recognizing the weight and importance of the mentioned factors through hierarchical approach and then with the aid of the Formula no.5 and Sugeno Fuzzy method the HRP is calculated.

2-Finding out the causes: the questions have been designed so that the respondent or the expert identify the cause of the existing situation.

3-Giving solution: to collect the proposals for solving the problem and finally classifying the solution, a module in the software has been allocated for the collection of the solutions from the respondents and experts and then combine them with the results of the past researches and theoretical discussions.

4-Considering the 'present state' and collected data, the mentioned system has been designed such that with the aid of Hill Climbing method, through searching the related Fuzzy rules and methods among the existing solution in the knowledge base, the most suitable and practical method for the rise of HRP is proposed.

As an example, a report base on that for an organization has been depicted in the figure 9.

The Alpha version of this software has been tested by virtual as well as the real data from two organizations, and reasonable results were acquired.

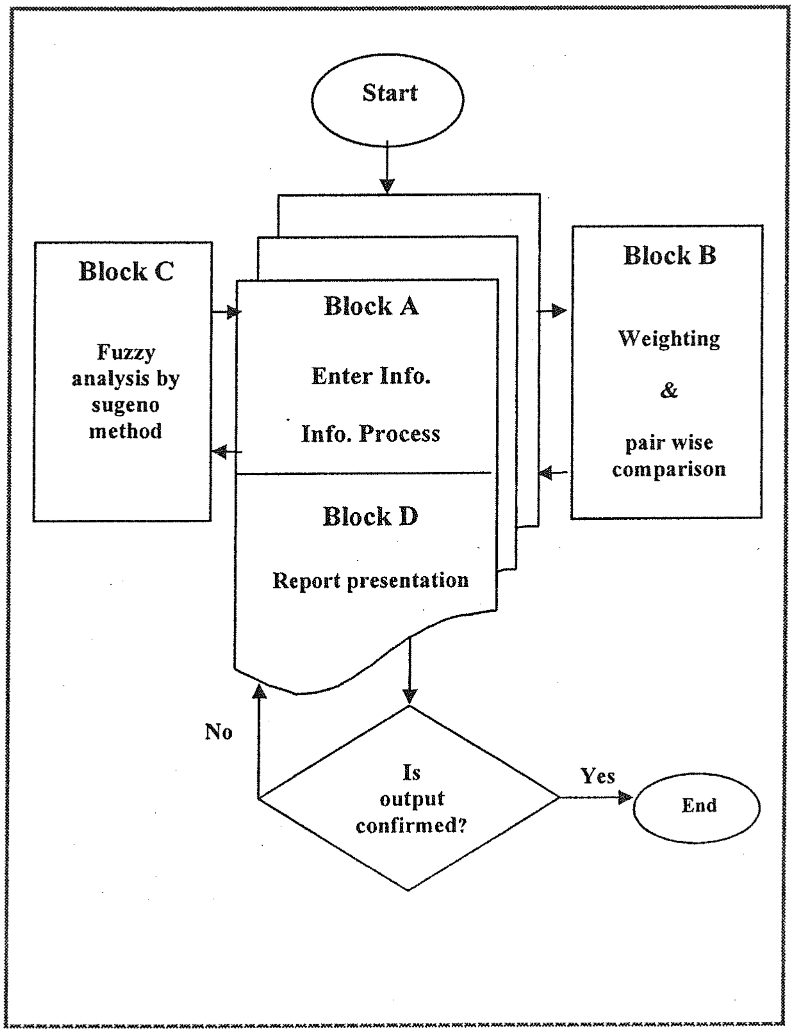

Figure 8- Decision support system operative algorithm.

7-Conclusion

In this article, we have tried to present issues and problems relating to Human Resource (personnel) productivity as an integrated process in an applied package, from a general, but novel point of view, so that the managers and engineers in the organizations can recognize all the essential interrelated elements of this process and employ them in their work according to the organization requirements.

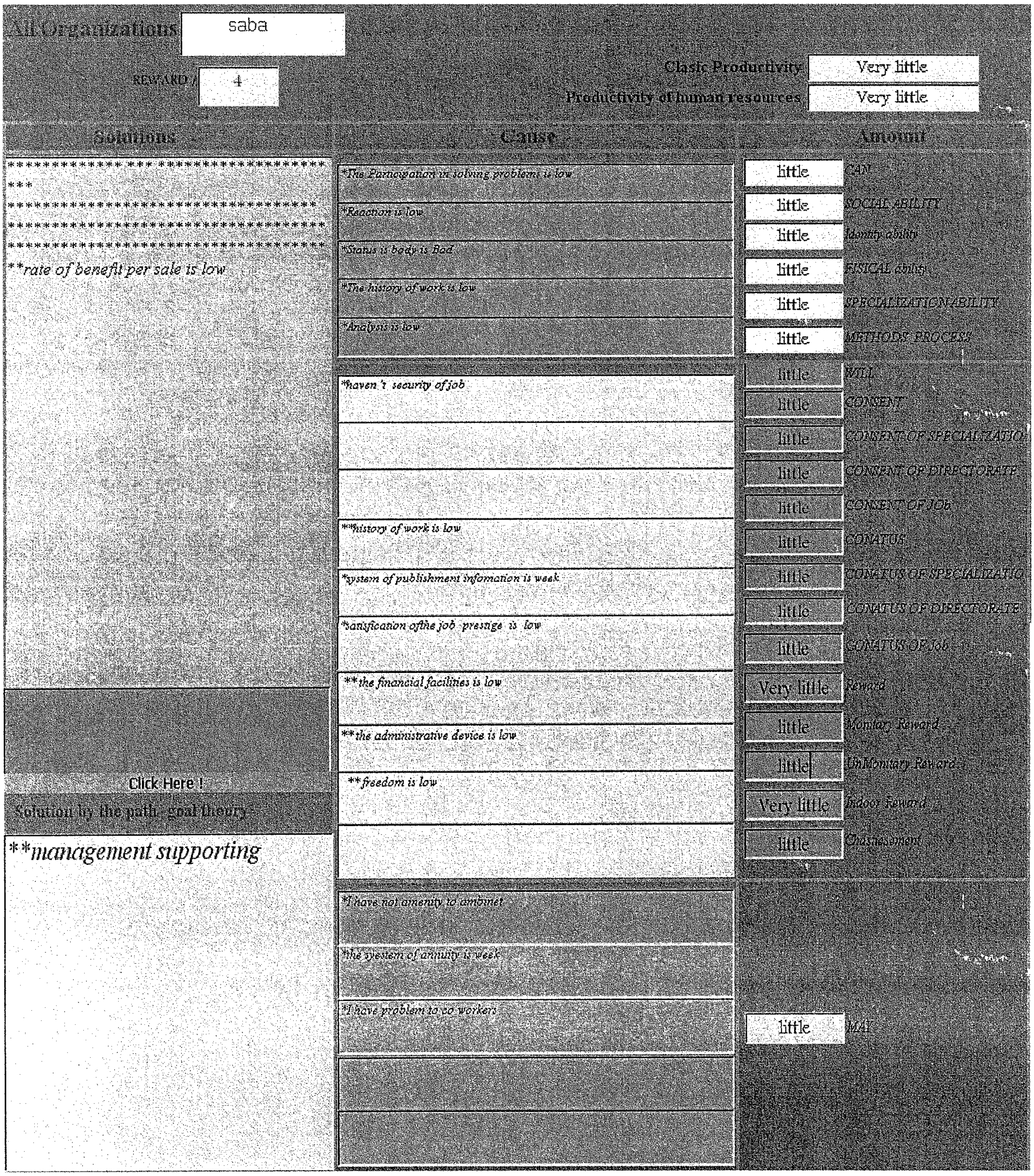

Figure (9) Solution presentation sample.

Main elements of the process are as follows:

-Recognition of main factors of HRP *(Will, Can, May)*. Each organization should recognize weight of determinative factors, which affect the above main factors,

-Representation of the HRP in a system with three main inputs *(Will, Can* and *May)* and one output (HRP) in order to be studied well and modeled,

-Representation of the mathematical model as a measurement instrument of the productivity (for the present situation, and other possible states).

-Seeking appropriate mathematical methods for calculation and representation of the mathematical model (here, fuzzy and discreet method) for calculation and representation of the model, which fuzzy method proved its superiority.

-Representation of possible states for determining existing situation and desired one.

-Recognition of situation and necessary planning for promotion of the Human Resource productivity,

-Proposing an algorithm for promotion of Human Resource productivity.(in this paper, a three- phase algorithm was introduced to solve this problems).

The presented method for measurement of the HRP with the capability of showing existing state and the desired one , together with the problem solving algorithm for the rise of HRP, can be utilized as a suitable base for the design of decision support system in various production and services organizations.

To illustrate the applicability of this claim, the alpha version of the decision support system which has yielded reasonable results, has been released.

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