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Expert System of Two-Stages in Simulated Environment for Selection of Staff

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Abstract: This article is an original work that presents an Expert System (ES) in fuzzy logic, to attend to the problem of selection of staff in a Persian Lime exporting company in Veracruz-Mexico. The ES is constructed considering a Recruitment stage, and a second Selection stage which is characterized in particular by being simulated in the vacancy functions called and including in that stage a TOPSIS module that helps to qualify complementary traits of the candidate. The use of the ES proves to be an effective support tool for the making decision, eliminates the vagueness of judges, and decreases administrative time in meetings for such activity. The criteria of selection of staff codified in the ES makes its use applicable not only to the exporting companies of this citrus, but can be extended to any other company.

Keywords: Human-automation interaction, intelligent systems, supervisory control, automatic and controlled processing, information processing.

I. INTRODUCTION

Human resource is a strategic resource that requires of a correct selection and professional management with the purpose to make competitive advantage from the job performance. Change of business environment provoked for a globalized economy as well as the continuous change technology, production system, and the way to management the company, demand more and more capable people for performing of the function organization which should be translated in the increase of quality results, labor productivity of the organization and levels of work satisfaction; opposite to this, could bring consequences such as the increase of the staff turnover, low learning curve, greater in-vestment in employee training, low employee productivity (Aguilar et al., 2014). With de purpose of improve productivity based in worker performance, companies and academics have been busy evaluating work environment and its conditions, as well as human resource skills in the performance of his work (Baumann et al., 2011).

Selection of staff is usually a management process which a number of people submit an evaluation of only one decision maker or decision making group supported of procedures and methods with the objective to evaluate skills, aptitude, human values, personality traits, among others, which normally involve personality tests, interview and curriculum evaluation to fill positions within a company (Canòs & Liern, 2008; Dursun & Karsak, 2010; Robertson & Smith, 2001), which can be divided in a recruitment stage and subsequently a selection of staff stage. In this sense, the simulated evaluation, as part of selection of staff has shown be a process through which can be integrated the subjective evaluation with staff

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performance measures in task assignment scenarios (Matthews, 2016).

Just like any decision problem, the selection of staff problem, by its essence of includes multiple criterial, as the presence of qualitative and quantitative factors makes decision a problem with extreme complexity of high human judgment, what incorporates an important subjectivity level of person or group of people responsible this process.

To attend these vagueness, the Fuzzy Sets Theory is used in decision problems with the purpose of translates human perception to numeric values to consider in quantitative form the vagueness of each decision criterial (Güngör et al., 2009); although its use has helped to decrease ambiguity and inherent subjectivity to decision of various industrial processes, application of fuzzy logic starts its biggest application boom to problems of selection of staff from the 90's (Butkiewicz, 2002).

The literature of last fifteen years – from 2000 to 2015 – reports a large amount of criterial decisions integrated to methods and/or techniques that hold the selection of staff problem, as well data mining (Chien & Chen, 2008), multi objective math programming Karsak, 2000), to start of Lee & Li (1993); works supported in fuzzy sets theory (Alguliyev et al., 2015; Kazan et al., 2015; Balezentis et al., 2012; Tabares et al., 2013; Yu et al., 2013; Afshari et al., 2013; Zhang & Liu, 2011); fuzzy logic inte-grated with ponderation and hierarchy methods (Bali et al., 2013; Özdemir, 2013; Aggarwal et al., 2014).

Others works such as Aksakal & Dağdeviren (2010) use the DEMATEL approach (Decision Making, Testing and Evaluation Laboratory) integrated with AHP (analytic hierarchy process); Akhlagh (2011) proposes a method based in approximate sets; while the Expert System has had a wide application to evaluation and/or selection of staff performance based in its professional competence (Aguilar et al., 2014), which have shown reliable enough. About Afshari et al. (2014) shows a revision of Applications of fuzzy decision making for personnel selection problem, and identify works that use different approaches that combine techniques with fuzzy logic to multi-criteria decision making (MCDM).

Three techniques standing out between commonly used in works to learn the selection of staff problem: AHP, TOPSIS, and Fuzzy Logic. Some Works report the use of fuzzy AHP (Güngör et al., 2009); others Fuzzy TOPSIS (Sang et al., 2015; Mammado-va & Jabrayilova, 2014), and another ones have used fuzzy AHP-TOPSIS (Vatansever & Oncel, 2014; Kusumawardani & Agintiara, 2015).

Bibliographic review reveals that selection of staff generally has used between three and eleven kinds of criterial as quantitative and/or qualitative, which can be classified in academic-professional dimension, and personal dimension, as well work experience, level of studies, ability in speaking and writing communication, a second language, teamwork, personality, experience in the respective area, between others related to any com-petition.

This article presents an Expert System (ES) supported with TOPSIS to selection of staff in two stages: recruitment and selection. The first stage qualifies curricular and professional criterial, while that, in the second stage, the candidate is submit-ted to a simulation of activities in real time to be qualified with criterial of performance of responsibility, leadership, and attitude. With the objective of weighing the competitive advantage not requested in the convocation, the ES is supported by TOP-SIS to integrated personal

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factors of each candidate that contribute to the function of the vacant.

The novelty of this ES is the opportunity of the Evaluation Committee to integrate the candidate evaluation in a performance process in a real-time environment and allows minimize prejudices, and the build of a clear judgment of Evaluation Committee to the vacancy requirements.

To prove the ES utility for selection of staff, the rest of this article is organized of next way: in Method section is described the ES design, and the focus of selection of staff supported of ES. Based in a case-study, in result section is attended the selection of staff problem for an agro-industrial company in Mexico. A discussion section in include at the end of this article in which the advantage of using of this ES is highlighted.

II. METHOD

This article presents an Expert System build according to Buchanan et al. (1983) who supports the selection of staff process in two stages, where every stage corresponds to one fuzzy module (MD): Recruitment (MD-R) and Selection (MD-S). the MD-R (stage 1) evaluates to candidate with criterial related to curricular dimension, and professional dimension, as well work experience, and demonstrated competencies in curriculum. MD-S (stage 2) evaluates the performance dimension, with activities in real time, and incorporates criterial that complement the generalities of candidate (GC). This MD-S supports with TOPSIS to rank particular criterial of interest to vacancy. Chart 1 define the criteria considered in the knowledge base of ES.

Level of curricular competition (LCC) – output from MD-R – is understood as the domain of the elements of the curriculum that shows candidate in the area of interest to occupy the vacancy, and define one of another vacancy. This LCC evaluation is carried out for a decision making group, to which are added those criterial that complement the generalities of candidate, which may vary according to the nature of the position. The values with greater weight, that is to say the most suitable candidates, are channeled to the next selection stage.

The number of candidates who pass to selection stage is determined by the top management of the company. El MD-S uses output values from MD-R, weighted value by TOPSIS related with general criterial (GC) to get Level of General Competence (LGC), and three candidate evaluation traits definite as Performance: Responsibility (R), Leadership (L), and attitude (A). these three traits are evaluated in real time for the Evaluation Committee.

Chart 1. Associated Criterial to Expert System to selection of staff.

Criteria	Description
Academic Training (AT)	It refers specifically and verifiably form to studies done by an individual.
Language (LE)	It refers to the fluent and / or written domain of a particular language required to ensure and maintain effective communication.
Work Experience (WE)	It refers to the time that the individual has worked in the area of a determined field as a professional activity.
Certification (CE)	Formal recognition of the work capacity demonstrated by a worker in the area of interest of the vacancy, without necessarily being the culmination of an educational process.
Training (TR)	Training or professional update in the area of interest of the vacancy demonstrated by the candidate.

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General Criterial (GC)	Refers to criteria that the candidate demonstrates documentary or product of a practice or derived from the interview process of the candidate facing the Evaluation Committee.
Level of Curricular Competence (LCC)	NCC refers to the output numerical rating of the MD-R from AT, LE, WE, and TR;
Level of General Competence (LGC)	LGC refers to the numerical rating of output estimated by TOPSIS, which serves as input to the MD-S.
Responsibility (R)	It refers to obtaining favorable results from the decisions taken and evaluating the impact of those decisions on the process.
Leadership (L)	It refers to the ability to communicate with a group of people and influence their emotions to make them collaborate as a work team
Attitude (A)	It is the voluntary disposition of a person facing the existence in general or a particular aspect of this.
(D)	Output variable of the SE, and corresponds to the decision to Contracting (C) or Non-Contracting (NC) / Promote (P) or Non-promote (NP).

With the objective of the ES covering a field of global evaluation of a company, criterial and traits of evaluation were defined as general criterial to performance of any function of the organization. The value range for each criteria and trait of ES evaluation was assigned by the top managers of three exporting companies of Persian lime of Citrus District III, from Veracruz-Mexico. Figure 1 show the ES structure for selection of staff.

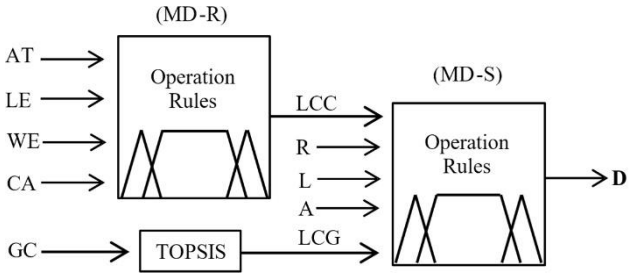

Figure 1. Structure of the Expert System to selection of staff.

Expert System development environment: The ES is designed with type IF-THEN rules, with Mamdani inference motor in MATLAB® DEMO 7.10.0.499 development environment (Matrix Laboratoy)

The Inference Motor for the Recruitment model in its knowledge base is defined by 108 operation rules, while for the Selection there are 458 rules. The linguistic variables and membership functions for each fuzzy module are described in Chart 2.

Chart 2. Input and output variables of the Expert System

Recruitment Module (MD-R)					
Dimension: Curricular					
Input criteria	Fuzzy Language	Fuzzy numbers	Output Criteria	Fuzzy Language	Fuzzy numbers
Academic Training	Technician	(0,2,5)	(LCC)	Low	(0,2,4)
	Degree	(3,5,7,8)			
	Postgraduate	(6,10,10)			
Language	Understanding	(0,3,5)			
	Fluid	(4,6,8)			
	Fluid and Writing	(5,10,10)			
Dimension: Professional Development				Medium	(3,5,8)
Profession	Not-	(0,4,7)			

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al Experience	affined				
	Affined	(5,10,10)			
Accredited Competence	Affined Training	(0,2,7)		High	(7,10,10)
	Affined Certification	(4,10,10)			
Selection Module (MD-S)					
Dimension: Performance					
Input criteria	Fuzzy Language	Fuzzy numbers	Output Criteria	Response variable ES	Fuzzy numbers
LCC	Low	(0,2,4)	(D)	(NC) o (NP)	(0,1,4,7)
	Medium	(3,5, 8)			
	High	(7,10,10)			
LGC	Low	(0.0,0.0,0.5)			
	Medium	(0.4,0.5,0.8)			
	High	(0.6,1.0,1.0)			
Responsibility	Low	(0,2,3)			
	Medium	(2,4,7,8)			
	High	(7,10,10)		(C) o (P)	(5,10,10)
Leadership	Low	(0,2,5)			
	Medium	(3,4,6,8)			
	High	(7,10,10)			
Attitude	Low	(0,2,4)			
	Medium	(3,4,6,8)			
	High	(6,10,10)			

The Figure 2 shows the ES user guide proposed to selection of staff. Once integrated the Evaluation Committee, and defined the contracting criterial, the evaluation committee register the criterial show for the candidate and they are evaluated to be used by ES in the MD-R. The output MD-R is expressed as LCC. The LCC value, and LGC provided by TOPSIS are integrated to the ratting of the evaluation in real time who recruited-candidate obtain for performance simulation of function to which it is submitted in a real environment in the company. MD-S finally provides a ratting into the scale response variable to Recruiting or Not-Recruiting / Promoting or Not-Promoting, according the case of decision.

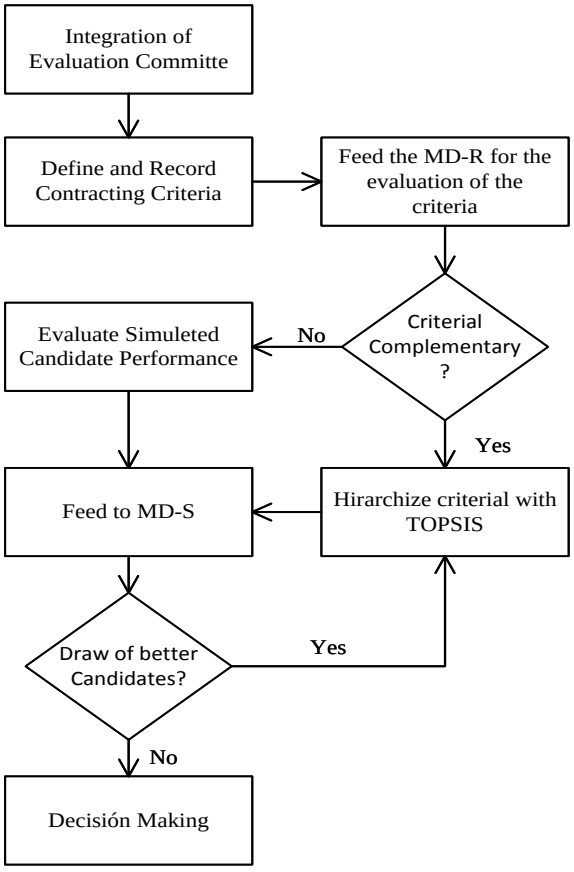

Figure 2. Focus to Selection of Staff based in the Expert System.

III. RESULTS

Case-study:

To demonstrate the utility of ES reported in this article, is attended the case to contract a production coordinator to the exporting company San Gabriel, S.A. de C.V. Evaluation criterial defined in the ES, describe in a curricular dimension and professional dimension. In this case-study were evaluated three candidates to occupy this job vacancy.

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Integration of Evaluation Committee: The Evaluation Committee is integrated by three functionaries of the company: Human Resources Manager, Quality Manager, and Production Manager.

Definition and Recording of Contracting Criterial: The contracting criterial defined by company are the Academic Training, Language, Work Experience, and Accredited Competition. General Criterial (GC) requested by the company are the Staff Management, Life Plan, and Excel® skills.

MD-R Evaluation and Feed for Expert System: Once registered the general information of the candidate, the Evaluation Committee proceeded to interview the candidate with base in the interview results, each Evaluation Committee member according to their perception, qualify Contracting Criterial related with Academic Training, Language, Work Experience, and Accredited Competition; subsequently the average of this evaluation is used by MD-R to get the LCC value for each Candidate, such as describe the Chart 3.

Chart 3. Candidate Evaluation related with Contracting Criterial.

MD-S	Input Values		
	Candidate		
Criteria	1	2	3
LCC	2.00	2.00	5.42
LGC	0.55	0.57	0.13
Responsibility	6.80	6.50	7.20
Leadership	6.70	6.60	6.60
Attitude	6.60	7.30	7.10

Note: Each Evaluator blindly qualifies each Candidate. The average rating of the Candidate is the arithmetic average of the rating assigned by each Evaluator.

TOPSIS Hierarchy: The Complementary Criterial are evaluated in TOPSIS, supported by SDI Tools 4®. GC to evaluate and their importance for the Decision Making Group are described in the Chart 4.

Chart 4. GC score assigned to each Candidate.

GC	Importance	Candidate		
		1	2	3
Life Plan	3	*7*	*5*	*4*
Excel® Skills	2	*5*	*9*	*6*
Experience in staff management	1	*4*	*8*	*4*
LGC value obtained from SDI Tools 4® software		**0.55**	**0.57**	**0.13**

Note: In case that the Decision Making Group doesn´t use this rating stage, the Decision Maker must assign the same numerical value of LGC to each Candidate to be used by the ES.

Simulation Performance Evaluation: Decision Making Group evaluates the performance in real time of each Candidate according to Responsibility, Leadership, and Attitude criterial. The score of each Candidate is described in Chart 5.

Chart 5. Average rating of simulated performance of Candidate 1, 2, 3.

Criteria	Candidate		
	1	2	3
Responsibility	6.8	6.5	7.2
Leadership	6.7	6.6	6.6
Attitude	6.6	7.3	7.1

Note: The Average value is the arithmetic average of the rating assigned by each Evaluator to each Candidate. In order to differentiate the average values, this value can be reflected in greater number of decimals.

MD-S Feed of Expert System: Values entered to MD-S from the ES are described in Chart 6, and results are shown in Chart 7. Although present output values for contracting, the Candidate 1

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with an output value of 8.21, in the more suitable Candidate to occupy the work vacancy. In case of draw, the Evaluation Committee will judge a new criteria of the candidate, and restart the process from curricular criterial presented by the candidates.

Chart 6. Input Values to MD-S of the ES.

Candidate	Input					Output	
	LCC	LGC	R	L	A	Value	Decision
1	2.00	0.55	6.80	6.70	6.60	8.21	Contracting
2	2.00	0.57	6.50	6.60	7.30	7.93	Contracting
3	5.20	0.13	7.20	6.60	7.10	8.03	Contracting

Note: This Chart 6 concentrates the values to be used by the MD-S. The LCC values of each Candidate are described in Chart 3; The LGC values in Chart 4; And the values of Responsibility, Leadership, Attitude, in Chart 5.

Chart 7: Output Values to the MD-S.

MD-R	Average Candidate Rating		
	Evaluator		
Criteria	1	2	3
Academic Training	*7.66*	*6.66*	*3.66*
Language	*6.00*	*3.66*	*8.00*
Experience	*2.33*	*7.33*	*4.00*
Accredited Competition	*2.66*	*5.66*	*4.00*
LCC Values obtained of MD-R:	**2**	**2**	**5.42**

Note: The output values are obtained from the MD-S, and based on the fuzzy numbers described in Chart 2, the Contracting or Non-Contracting Decision is taken.

As shown in Chart 7, the ES has converted in fuzzy numbers the numeric numbers fixed by the Evaluation Committee in a criteria series of one group of candidates, to set one fuzzy score using the operation rules described by the panel of experts who gave origin to the inference motor of the ES to select the best alternative of staff between three alternatives, which different of traditional methods of selection of staff, the numeric information generated for each criteria in this ES, minimize the related conjecture with the need of training to start of scores for each criteria obtained for the selected candidate. For example, the case study exposed in this paper, stand out the need to give training to the candidate 1 in aspects of the foreign language and staff management. In this sense, the way of organization of the information and records generated by the ES, let integrate information for the human resource management based in personal growth program.

Finally, the ES structure developed in a MATLAB® environment and harmonized with TOPSIS on SDI Tools 4®, is presented with a new method in the selection of staff in contrast with evidence presented by the Candidate, with his performance in a simulated scene.

IV. Discussion

As decision support, this focus selection of staff has demonstrated to be adaptable so that selection of staff process when considered defined criterial by the company, together with particular criterial to the function of vacancy. The integration of TOPSIS to ES allows who decision maker considers in the evaluation process curricular and/or personal aspects from candidate that contribute to get better performance in the vacancy, likewise, the results of ES also provides to decision maker the need of training to get better the staff performance.

The ES has demonstrated its efficacy in selection of staff in a more agile way respects to the traditional methods who demand an evaluation series based in teste and/or interview with the decision maker that cannot be quantified. However, even the ES provides information to

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identify the need of staff training, the ES user carries de risk to do a wrong measurement when don´t have a clear scale of values defined by each criterial in the evaluation process. To minimize this risk, is recommended, as a future work, set coefficients of importance to the decision criterial defined in the ES knowledge base.

In the search of new ways to solve the selection of staff problem, the literature review of last five years allows let us see that to attend this problem has been frequent the use of ES accompany of AHP, and TOPSIS, in that operation mechanism usually are attractive, however, the evaluation process considers only curricular criterial. In this sense, the focus of selection of staff that we have presented in this paper, is reasoned in a process of evaluation that considers the curricular level of the candidate, and a simulated performance evaluation process, so the focus of selection of staff supported in ES, is considered as original in two aspects:

1. The result of the evaluation of candidate to be contracted allow identify need to the human resource management, to design the training and personal growth programs.
2. The Opportunity that the Evaluation Committee has to integrate in a performance process of the candidate in a simulated work environment allows minimize prejudge, and the consequence of built a judge with less bias to the need of the job vacancy.

Finally, we must highlight that second stage of this ES allows to the decision maker of the company, contrast the curricular evidence presents by the Candidate, through of his performance in a simulated scene.

V. KEY POINTS

- The possible draw of results, can be differentiated with particular criterial weighted by TOPSIS.
- The ES user has the risk to realize a wrong measurement when it is no clear the values scales defined in the knowledge base of the ES.
- The evaluation result of staff allows to integrate information to the human resource management of the company.

VI. ACKNOWLEDGMENTS

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