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Fuzzy Inference System to Assess Entrepreneurial Self-Efficacy

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Abstract: ***En este estudio se utiliza un sistema de inferencia difusa para medir la autoeficacia empresarial (ESE) basado en características emocionales. Se adquirió un conjunto de datos con varias características orientadas a la Teoría del Comportamiento Planificado de 741 sujetos. Se aplicaron las cuatro etapas siguientes: i) preprocesamiento de los datos, ii) correlaciones de variables para definir la influencia de las variables emocionales en la ESE, iii) sistemas de inferencia difusa (FIS): en esta etapa se establecieron las reglas basándose en los resultados del análisis estadístico y en los conocimientos de los expertos. iv) Se llevó a cabo la evaluación del FIS para medir su rendimiento. Los resultados demostraron la funcionalidad del modelo y se desvelaron sus ventajas, limitaciones y trabajos futuros. En este estudio se constató que, a medida que mejora la inteligencia emocional de las personas, éstas adquieren una mayor autoeficacia empresarial, lo que conduce a un mayor éxito como empresarios, que se modeló adecuadamente con el FIS desde multiples variables de entrada.***

Keywords*: Emotional intelligence, Entrepreneurial Self-Efficacy, Entrepreneurial intention, Fuzzy inference system.*

I. INTRODUCTION

The entrepreneurial attitude is highly desirable in a country's economy as it allows for economic growth of a country's GDP and decrease in unemployment rate [1][2]. However, the entrepreneurial attitude is closely linked to the culture and training of the individual. Thus, individuals with a high entrepreneurial attitude have great abilities to identify opportunities for new business ventures. Individuals constantly find opportunities, but not everyone has the ability to recognize them and transform them into successful enterprises. Identifying the right entrepreneurial opportunity is an intention-driven behavior. Entrepreneurial intention largely predicts entrepreneurial behavior. Therefore, investigating the motivation underlying entrepreneurial intention is considered an important activity that helps to understand and predict entrepreneurship [3][17][19]. Although intention is a very strong predictor of actual behavior, it must be specified that intention formation may be identified long before the actual behavior, and also the behavior may never take place. Theory of Planned Behavior, Entrepreneurial Self-Efficacy (ESE) is related to individuals' beliefs about their entrepreneurial skills [4][5][18][21] and influenced by socioeconomic variables, emotional intelligence, entrepreneurial intentions and behaviors among others, however, emotional intelligence and other intrapersonal traits are considered to be among the most relevant [6][7][8]. The literature reports some studies on emotional intelligence and entrepreneurship, however there are few reports related to models to assess the entrepreneurial attitude in terms of emotional intelligence [9][10][11][12][13][20]. Considering the above, this study proposes a fuzzy inference system (FIS) [14] for the assessment of entrepreneurial attitude as a function of variables related to emotional intelligence. A statistical study was carried out from an analysis of 741 respondents to identify influential variables for the valuation of entrepreneurial attitude. The FIS was then constructed with expert support for the construction of the rules and functional validation of the proposed system. The results demonstrated the scope and limitations of the system, being considered as a powerful tool for decision support in this field.

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II. EXPERIMENTAL SETUP

A. Proposed Methodology

In Figure 1 is shown the addressed methodology. This shows the different stages of the methodology applied for the development of the entrepreneurial attitude measurement system, which was carried out in 5 stages: i) In the first stage, data collection was carried out by applying an instrument to a sample of 741 individuals. ii) In the second stage, the statistical analysis of the results of the instruments applied was carried out to identify the influential variables in the assessment of the entrepreneurial attitude. iii) In the expert analysis stage, rules were established based on the relevant characteristic for the construction of the fuzzy inference system. iv) The fuzzy inference system is constructed with the rules established in the previous point, v) finally, the functionality of the model is validated using surface diagrams.

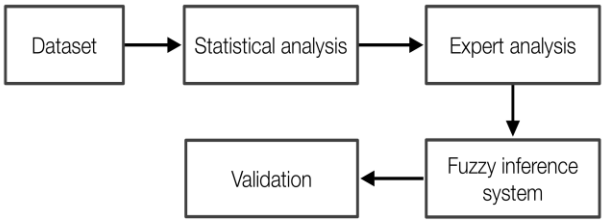

Fig. 1. Proposed Methodology

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III. RESULTS AND DISCUSSION

Correlation analysis showed with a p-value= 0.05 that the variables that presented the highest degree of correlation with respect to the ESE are: Autonomy (A), Risk taking (Rt), Optimism Locus of control (OLC), and Innovation (INN). On the other hand, the control variables such as Age, gender, Student, Entrepreneur and Employee have a very low correlation and are therefore considered to be of little contribution to the measurement of entrepreneurial attitude.

Figure 2 shows the proposed and implemented fuzzy inference system with four inputs and one output corresponding to the ESE valuation.

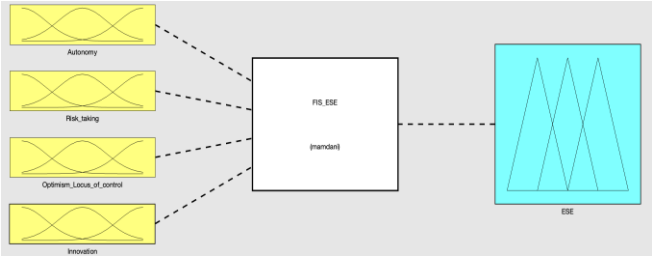


Fig. 2. Fuzzy Inference System – ESE Assessment System

Based on the influential variables on entrepreneurial attitude the rules were constructed considering 3 qualitative ratings for each variable (H: high, M: Medium, L: Low) as illustrated in the following Table 1.

Table- I: Rules of FIS

A	Rt	OLC	INN	ESE
H	H	H	H	H
H	H	H	R	H
H	H	R	H	H
H	R	H	H	H
R	H	H	H	R
H	H	R	R	H
H	R	H	R	R
R	H	H	R	R
H	R	R	H	R
R	H	R	H	R
R	R	H	H	R
R	R	H	R	B
H	H	H	B	H
H	H	R	B	R
. . .	. . .	. . .	. . .	. . .
B	B	B	B	B

Figure 3 Shows the Structure of Fuzzy Sets (Low, Medium and High) with Their Scales [0 1].

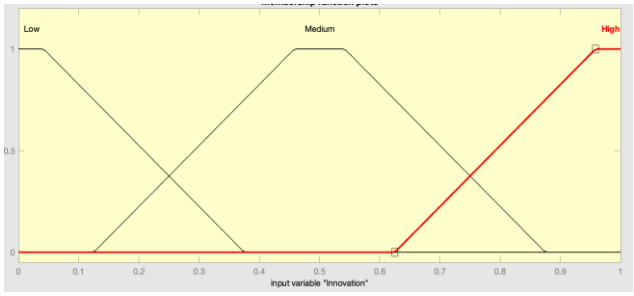


Fig. 3. Fuzzy Set For Innovation

Figure 4 shows surface diagrams which demonstrated the functionality of the proposed system. They shown that the most influential variables are Autonomy Risk taking, which is completely consistent with the results since these are the most influential or most important variables. Additionally, the coherence of the measurement is evident.

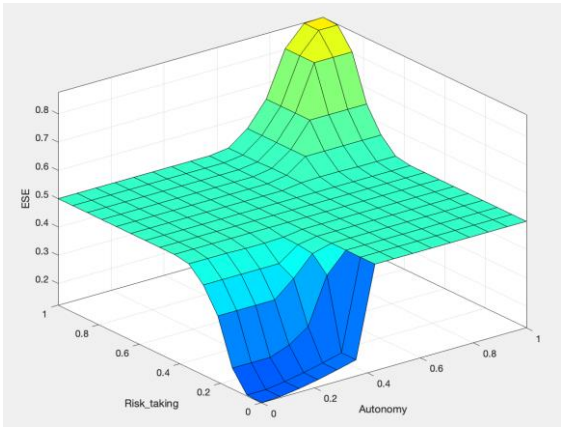
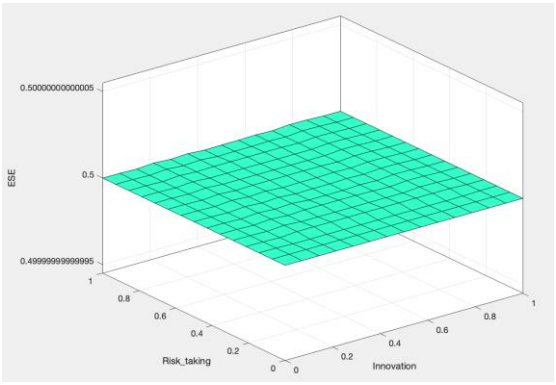


Fig. 4. ESE Assessment Risk_Taking Vs Autonomy



a) ESE Assessment Risk_Taking Vs Autonomy

IV. CONCLUSION

This study proposes a system for the valuation of the entrepreneurial attitude in Colombia, for which a set of weighted metrics was defined and integrated in 4 criteria and modeled in a Mamdani type fuzzy inference system. The system showed an adequate performance according to the valuation made by the experts based on the different metrics given by them. In spite of this, it is considered that an assessment and tuning of the system in terms of the fuzzy sets and rules should be carried out in order to minimize the error. As a future work, it is proposed to model the valuation system of the ESE sufficient to train a learning machine and compare it by means of performance metrics with the fuzzy inference system and a hybrid system based on the FIS that allows an adequate tuning of the system. In addition, a framework based on JDL data fusion and information quality could provide a complete evaluation of the ESE in terms of risk, impact and situation taking into account data quality [15][16].

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DECLARATION STATEMENT

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material	Not relevant.
Authors Contributions	All authors have equal participation in this article.

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Yesica Rodas-Cano is a mechanical engineer from Institución Universitaria Pascual Bravo in Medellín, Colombia, and holds a technical degree in Business Administration. Throughout her career, she has actively participated in various research projects, demonstrating a strong commitment to advancing her field. Specializing in transportation, Yesica has developed a keen expertise in addressing complex engineering challenges related to this sector. Her background in business administration complements her technical skills, enabling her to manage and lead projects effectively. Additionally, Yesica is an entrepreneur, having initiated and managed innovative projects that intersect technology and mobility. Her combination of engineering acumen, business management skills, and entrepreneurial spirit drives her continuous pursuit of innovative solutions in the transportation industry.

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