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ORIGINAL

A Fuzzy Logic-Based Decision Support System for Predicting Entrepreneurial Intention Among Textile Students

Un sistema de apoyo a la toma de decisiones basado en la lógica difusa para predecir la intención empresarial entre los estudiantes del sector textil

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ABSTRACT

This article presents a fuzzy logic-based decision support system, which functions as a predictive model for assessing and guiding entrepreneurial intention among Moroccan university students in the textile sector. The model used four key variables, namely Desirability, Self-Concept, University Context, and Feasibility. These latter and their influence were identified through a previous ANN model. Fuzzy memberships functions were designed, and 81 expert validated rules were constructed for the fuzzy model. The model provided entrepreneurial scores based on the students' inputs and was tested on a new 40 student survey responses. Key findings highlighted that desirability and self- concept are critical drivers of entrepreneurial intention, and the results showed an alignment with expert judgments and theoretical models. Furthermore, the model provided personalised recommendations for both students and university and makes clear contributions to both theoretical and practical advancements in the entrepreneurship studies.

Keywords: Entrepreneurial Intention; Fuzzy Logic; Higher Education; Textile Sector; Educational Recommendation System.

RESUMEN

Este artículo presenta un sistema de apoyo a la toma de decisiones basado en la lógica difusa, que funciona como un modelo predictivo para evaluar y orientar la intención emprendedora entre los estudiantes universitarios marroquíes del sector textil. El modelo utilizó cuatro variables clave, a saber, Deseabilidad, Autoconcepto, Contexto universitario y Viabilidad. Estas últimas y su influencia se identificaron mediante un modelo RNA previo. Se diseñaron funciones de pertenencia difusas y se construyeron 81 reglas validadas por expertos para el modelo difuso. El modelo proporcionó puntuaciones empresariales basadas en las aportaciones de los estudiantes y se probó con las respuestas de una nueva encuesta a 40 estudiantes. Las principales conclusiones pusieron de relieve que la deseabilidad y el autoconcepto son factores determinantes de la intención emprendedora, y los resultados mostraron una alineación con los juicios de los expertos y los modelos teóricos. Además, el modelo ofreció recomendaciones personalizadas tanto para los estudiantes como para la universidad y hace contribuciones claras a avances teóricos y prácticos en los estudios sobre el espíritu empresarial.

Palabras clave: Intención Emprendedora; Lógica Difusa; Educación Superior; Sector Textil; Sistema de Recomendación Educativa.

INTRODUCTION

Entrepreneurial intention (EI) is a fundamental pillar in the promotion of entrepreneurship, playing a key role in transforming ideas into concrete action. It represents the first step in the entrepreneurial process, enabling individuals to consciously engage in activities aimed at creating and developing businesses. As a predictor of entrepreneurial behaviour, EI is essential for stimulating business creation, fostering innovation and contributing to economic and social growth. Previous research has exploited artificial neural networks (ANNs) to model entrepreneurial intentions, highlighting their ability to analyse complex relationships between influential variables. However, these approaches are often criticized for their lack of interpretability, which limits their practical utility for educators and policymakers. Faced with this shortcoming, it becomes imperative to explore more transparent and comprehensible methods, such as fuzzy logic, in order to translate complex results into usable and accessible rules. This research focuses on developing an interpretable fuzzy logic-based model to predict EI. Combined with ANN-derived data and insights, a rule-based fuzzy system is constructed. In the Moroccan context, the textile industry occupies a strategic position due to its economic weight and job creation potential. Encouraging entrepreneurial intentions in this sector is particularly crucial to revitalize the industry, strengthen its competitiveness and promote sustainable development. The EI of students and young entrepreneurs in Morocco, particularly in the textile field, offers a unique opportunity to boost this sector by integrating innovation and creativity. Few studies have been focused in the textile sector students and no existing decision-support systems have been tailored to this population.

This paper presents a novel integration of ANN and fuzzy logic in entrepreneurial research on textile undergraduate and postgraduate students in the Moroccan context. Furthermore, a recommendation system is constructed to tailor to support students and universities with actionable insights to foster entrepreneurship.

Literature review

Theoretical Foundations of Entrepreneurial Intention

Entrepreneurship plays a vital role in promoting economic growth, enhancing competitiveness, creating employment opportunities, and fostering national prosperity.[1] Hence, and expanding interest on entrepreneurship and business education have surged globally. Numerous studies have explored the entrepreneurship process from various angles. A key focus within entrepreneurship research have been on understanding the factors that lead individuals to engage into entrepreneurial activities.[1,2] Some researchers focused on the downstream factors such as the personal and professional attributes of entrepreneurs to understand the evolution of their behaviour, whilst others concentrated on the upstream perspective examining the learning process and factors influencing it.[3]

Entrepreneurship process is complex and multi staged, among which is the development of Entrepreneurial intention.[1] The latter is widely recognised as a prominent predictor of entrepreneurship activities.[1,2,4] The term intent, from an epistemological viewpoint, involves the conscious alignment of the individual's state of mind towards achieving a particular goal. It often represents the commitment and engagement of the individual towards starting a business.[5] Intent, thus, explains the individual's engagement in entrepreneurial behaviours and decisions to start a business.[2] A stronger intention to engage in entrepreneurial behaviour significantly increases the likelihood of successfully performing that behaviour.[1] Given the crucial role of EI, researchers have emphasized understanding the factors shaping it, especially among students and potential entrepreneurs in higher education settings.

Intent-based models and frameworks commonly utilised in entrepreneurial research include Ajzen's Theory of Planned Behavior (TPB),[6,7] Shapero and Sokol's Entrepreneurial Event Model (EEM),[8] and McMullen and Shepherd's Model of Entrepreneurial Action.[9] These models emphasize the importance of an individual's perceptions regarding the desirability and feasibility of pursuing entrepreneurial actions.[2]

Ajzen's Theory of Planned Behavior (TPB) is among the most widely referenced frameworks in entrepreneurial intention research.[2,3] According to this theory, entrepreneurial intention is driven primarily by an individual's perception of the desirability and feasibility of starting a business.[8,9] TPB theorize that entrepreneurial intention results from three fundamental factors: attitudes toward entrepreneurship (personal desirability), perceived behavioural control PBC (feasibility), and subjective norms (social influences).

Similar models by Shapero et al.[8] Tounes et al.[10] strengthen these factors by emphasizing self-efficacy, entrepreneurial rewards, academic support, and personal experiences.[11] Additionally, socio-cognitive career theory by lent[12] adds students' learning environments and personal traits as factors that shape entrepreneurial self-efficacy and intentions, driving subsequent entrepreneurial actions.[3]

Two distinct research strings can be found within the EI literature, one from the social psychology point of view and the other specific to the entrepreneurship field.[13] Recently, additional theoretical perspectives have been introduced, showcasing the growing diversity and complexity of this research strand.[2] Various entrepreneurship intention models have been widely applicable and compatible across various contexts. However, this growth in EI studies since the nineties has also revealed inconsistencies, mismatches within the literature, highlighting ongoing theoretical and methodological challenges.[13]

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Artificial intelligence (AI), particularly artificial neural networks (ANN), has recently been extensively used in entrepreneurial intention research. ANN techniques present numerous advantages helping in modelling complex and nonlinear relationships between entrepreneurial intention and their influencing variables.[14] In particular, this study is an extension to our previous work[15], where an ANN model was used to predict and assess four variables and their influence on the entrepreneurial intention within the textile university students in Morocco.

Despite their significant developments, ANN approaches are often criticized for their "black-box" characteristics, considering their complexity and lack of reasoning and explanation of the decision process.[16] This interpretability gap restricts the practical utility of the findings, especially for educators and policymakers aiming for actionable insights.

Due to these limitations, a growing need for transparent methods have surged in the EI literature, highlighting the potential of fuzzy logic models.[17] Fuzzy logic emerges as a promising alternative, complementing ANN approaches by translating complex, nonlinear predictions into human-readable rules.[18] Fuzzy logic effectively translates subjective and qualitative assessments into structured, interpretable rules, facilitating easier understanding of complex relationships and enabling actionable decision-making.

Fuzzy logic in Entrepreneurial Intention research

Fuzzy methods are particularly designed to address complex and imprecise problems. By mirroring the way humans naturally reason through uncertainty, fuzzy logic provides a structured approach to interpreting complex scenarios. Consequently, fuzzy logic provides managers a reliable methodology for decision making.[19]

Fuzzy logic first emerged in the mid-1960s, initially introduced by Zadeh[17] and has since gained widespread recognition. It is rooted in observations of human decision-making processes, pinpointing how in situations where individuals encounter uncertain, incomplete, or ambiguous situations, they still often manage to make accurate and effective decisions.[20] By integrating ambiguous human judgments and expertise into computational models, fuzzy logic enables efficient conflict resolution among multiple criteria and ameliorate the evaluation of ambiguous scenarios.

The main advantages of fuzzy logic include formalising and stimulating the report of an expert in the conduction process,[20,21] using linguistic description and assessments,[18,21] and better resolution of conflicted multiple criteria problems.[21,22] Consequently, fuzzy logic-based methods have been increasingly adopted in intelligent systems for decision-making, optimization, pattern recognition, identification, and control applications.[22] Studies have demonstrated the relevance of the methodology in optimising industrial processes, particularly in the context of textile engineering[23,24,25,26] and decision making.[27,28,29] Furthermore, the application of AI combined with fuzzy logic has shown valuable results, especially in the textile industry.[30,31]

The application of fuzzy logic extends beyond technical contexts, playing a significant role in entrepreneurship research and broader social sciences,[20,32,33,34] demonstrating its ability in capturing the subjective nature of entrepreneurial decisions.[35,36,37,38]

To systematically summarise the research on EI,[19] have conducted a thorough literature review of existing studies utilizing fuzzy logic methodologies within entrepreneurship research. A study have introduced a fuzzy decision-making model and used clustering method to evaluate entrepreneurial intentions within the Indonesian context.[39] The authors have merged fuzzy logic with TPB to ameliorate the assessment and clustering of potential entrepreneurs.

A study have applied Fuzzy Cognitive Mapping (FCM) to explore and strengthen female students' entrepreneurial intentions. Key motivations and influential factors were identified through fuzzy cognitive maps for a better targeted support to entrepreneurial intent among the female students in particular. Furthermore, the recent paper by [40] have explored the application of fuzzy control algorithms to model and evaluate entrepreneurial intentions among college students, presenting valuable insights and actionable strategies for improving entrepreneurial intention among students.[41]

Key Entrepreneurial Intention Factors

This study focuses on four factors that have been identified through a study based on an ANN approach. The study identified the influencing entrepreneurial intention factors among Moroccan higher education students, specifically in the textile and clothing sector.[15] These factors are:

Desirability: this factor reflets the personal attraction and social encouragement towards entrepreneurial activities. Desirability captures the individual's intrinsic motivation and external influences such as family support, societal recognition, and personal aspirations.[42,43,44,45,46] the results from [15] indicate that desirability and social norms are the most influential driver of entrepreneurial intentions.

Self-Perception: the second factor analysed is self-concept, one of the main constructs of the TPB, referring to the individual's perceived competencies, such as creativity, leadership, and risk-taking.[47,48] Findings from [15] have highlighted the existing relationship between positive self-perception and entrepreneurial intent,

showcasing a significant influence on entrepreneurial intention; higher self-confidence directly correlates with increased motivation and a stronger likelihood of pursuing entrepreneurial goals.[49,50,51,52]

University Context: this factor encompasses the academic environment, including entrepreneurial training, mentorship, coaching, and practical exposure to entrepreneurship. The impact of the university context on entrepreneurial intention have garnered considerable interest among scholars, leading to numerous mixed findings; from significant impact to limited or inconclusive influence.[47,48] Likewise, reference[15] highlights a moderate influence on EI, specifically, the study indicated that academic environments that provide practical experiences, entrepreneurship-oriented training, and mentoring significantly enhance students' entrepreneurial intentions.

Feasibility: this factor includes practical considerations such as the accessibility to financial resources, technical skills necessary for business initiation and administrative support. Interestingly, the analysis from reference[15] have showed limited impact of the feasibility, suggesting that practical constraints, while important, were perceived less critical compared to motivational and self-concept factors. However, administrative constraints remain significant barriers perceived by students, reflecting real-world complexities associated with business creation.[15]

Findings from[15] indicated that desirability and self-perception stand out as the primary drivers of entrepreneurial intention, while university context and feasibility play significant supportive roles. Following these findings, this paper aims to construct a fuzzy logic model, considering these 4 variables as inputs. Fuzzy logic complements traditional and ANN-based approaches, addressing the crucial gap of interpretability and enhancing decision-making transparency in entrepreneurial intention modelling.[18]

In summary, while extensive research has investigated entrepreneurial intentions and their determinants through various frameworks and approaches, this study addresses a clear gap identified in existing literature by integrating insights from ANN-based entrepreneurial intention model with a transparent and interpretable fuzzy logic approach. By translating these findings into a rule-based structure using fuzzy logic, this paper aims to provide a tailored recommendation system for both students and universities, specifically in the textile and clothing setting.

METHOD

Research Design & Data Source

Fuzzy Logic is a nonlinear computational approach designed to handle uncertainty and vagueness, bridging qualitative symbolic and quantitative numeric concepts.[53,54] A typical fuzzy inference system (FIS) comprises four main stages: fuzzification, rule-based inference, aggregation, and defuzzification.[54,55,56] Fuzzification converts crisp input data into fuzzy sets, while inference uses rules to interpret these fuzzy inputs.[57,58,59,60] Aggregation combines these rules, and defuzzification translates the fuzzy output back into a precise numerical result.[54] Figure 1 illustrates the overall structure of this fuzzy logic process.

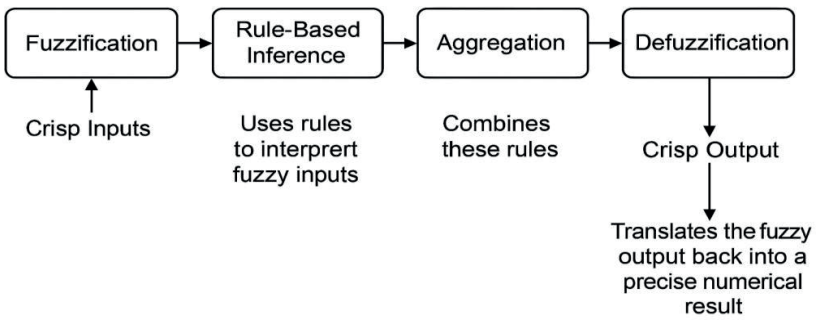

Figure 1. Structure of the Fuzzy Inference System

The first step in this study was to define the input and output variables that will be used on the fuzzy model. The selection of variables is based on the ANN -based study on entrepreneurial intentions among university students in the textile sector in Morocco[15] The four variables: desirability, self- concept, university context and feasibility are briefly discussed on the literature review section and thoroughly explain in.[15] Moreover, the authors used the data from the questionnaire-survey used to construct the ANN-based model.

Development of the Fuzzy Logic Model

The fuzzy logic model is structured with four input variables, Desirability, Feasibility, Self-Perception, and University Ecosystem, previously identified as influential in the ANN-based entrepreneurial intention model. The output of the system is an entrepreneurial intention score, indicating the likelihood that a student will pursue entrepreneurial activities.

Fuzzification Process

Fuzzification translates numerical survey responses into linguistic variable representing qualitative judgments. Each factor is represented by linguistic terms: Low, Medium, High.

The construction of the membership functions (MFs) is based on the results of the student survey and the relative influence of each variable on entrepreneurial intention. The four main variables are Desirability (D), Self-perception (SP), University Context (UC) and Feasibility (F). Statistical analysis in [15] showed that Desirability (40 %) and Self-perception (30 %) have the strongest impact on entrepreneurial intention, while University Context (15 %) and Feasibility (10 %) play a secondary role. In addition, based on the responses extracted from the survey, the average values for each key variable are as follows:

Table 1. Survey-Based Averages of EI variables

Variable	Average Response (%)
Desirability	61,07
Self-Perception	65,06
University Context	57,50
Feasibility	55,17

- For variables with a strong influence (D & SP): the value ranges for “Moderate” and “High” are wider to better represent their dominant effect.
- For variables with low influence (UC & F): the transitions between “Low”, “Moderate” and “High” are narrower as they have a lesser effect on final intention.

$$u(x) = \begin{cases} 0 & x \le a \\ \dfrac{x-a}{b-a} & a \le x \le b \\ \dfrac{c-x}{c-b} & b \le x \le c \\ 0 & x > c \end{cases}$$

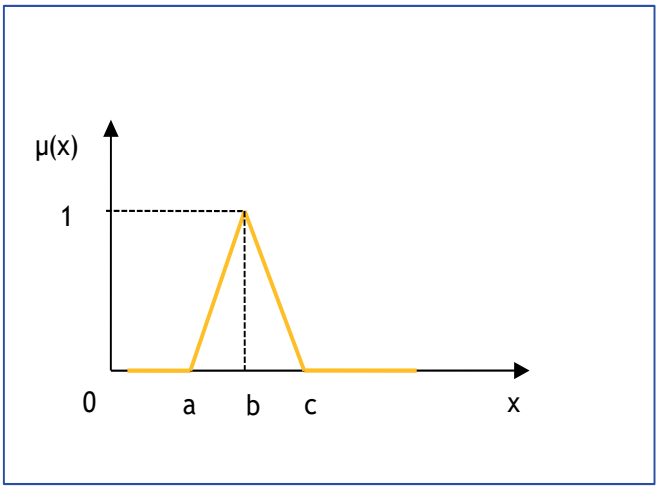

Figure 2. The triangle Membership Function representation

Considering the latter, the triangular memberships functions were chosen to model the input variables. Triangular functions allow a smoother transition and classification of categories reflecting real-world decision-making process.

The equation of the triangular membership functions is as follows,[54] and figure 2 showcases a graphical presentation of the function. Triangle membership function.

For the output (entrepreneurial Intention), a combination of trapezoidal and triangular membership functions was chosen to optimise the categorisation accuracy. Triangular functions for low and high categories for well-defined and precise boundaries. Whereas the trapezoidal function was used for the moderate category to allow a broader range and prevent abrupt transition.

The trapezoidal function formula and graphical presentation are as follows:

$$u(x) = \begin{cases} 0 & x \le a \\ \dfrac{x-a}{b-a} & a \le x \le b \\ 1 & b \le x \le c \\ \dfrac{d-x}{d-c} & c \le x \le d \\ 0 & d \le x \end{cases}$$

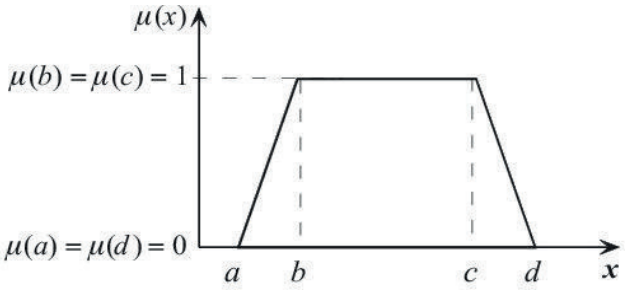

Figure 3. The trapezoidal Membership Function representation

Rule-Based Fuzzy Inference System (FIS)

Fuzzy inference rules are developed by experts considering the degree of influence of each variable on entrepreneurial intention. We used an "if-then" logic, where each combination of variables leads to an estimate of the level of entrepreneurial intention (Low, Moderate or High).

The classification of outcome EI as "Low", "Moderate" or "High" is based on the weighted sum of the input factors Desirability (D), Self-perception (SC), University Context (UC) and Feasibility (F). Each factor can take three levels (Low = 1, Medium = 2, High = 3) and is multiplied by a specific importance coefficient according to their impact on Intention.

Each variable is divided into three fuzzy sets (Low, Medium, High). The input values have different ranges based on their relative influence. A weighted sum approach is used and is expressed by the formula:

$$EI_{deg} = \frac{w_1 D \pm w_2 \mathrm{SP} \pm w_3 \mathrm{UC} \pm w_4 \mathrm{F}}{D + CS + UC + F}$$

Table 2. EI formula notation and assigned weights

Symbol	Definition	Weight Symbol	Weight
D	Desirability degree	w1	4
SP	Self-perception degree	w2	3
UC	University Context degree	w3	2
F	Feasibility degree	w4	1

The weighted sum obtained is then compared with defined thresholds to determine the exit category.

$$\begin{cases} EI_{Category} = \text{"Low"} & if\ EI_{deg} \le 16.67 \\ EI_{Category} = \text{"Medium"} & if\ 16.67 < EI_{deg} \le 23.33 \\ EI_{Category} = \text{"High"} & if\ EI_{deg} > 23.33 \end{cases}$$

To enhance the accuracy, the rules were then refined by experts to ensure consistency with real world behaviour.

An illustrative example of a fuzzy rule is: "If Desirability is high, Self-perception, University Context and Feasibility are low, then Entrepreneurial Intention is Medium.". Table illustrates a snapshot of the conception of the rules.

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Table 3. Fuzzy rules

Rule no.	D	SP	UC	F	Output
1	Low	Low	Low	Low	Low
2	Medium	Low	Low	Low	Low
3	High	Low	Low	Low	Medium
.....	.....	.....	.....	.....	.....
79	Low	High	High	High	Medium
80	Medium	High	High	High	High
81	High	High	High	High	High

Defuzzification

Once the entrepreneurial intention has been evaluated by the inference rules, it needs to be converted into a precise value on a scale of 1 to 5 in order to interpret the results. There are five primary methods used for defuzzification: centroid, bisector, middle of maximum (the average of the maximum values), largest of maximum, and smallest of maximum.[53] Among these, the centroid method is most widely used.[53]

The discrete centroid defuzzification formula calculates a crisp output value y by computing the weighted average of all discrete values Y0: according to their membership degrees $\mu(Y0)$:

- y: the crisp numeric output after defuzzification.
- Y_0: each discrete possible output value.
- $\mu(Y0)$: the membership degree of each value yi.

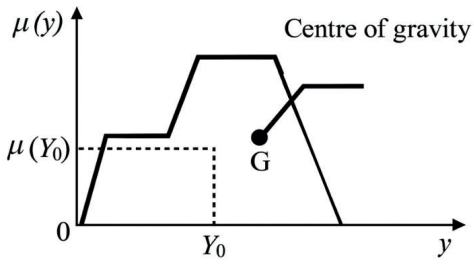

Figure 4. The centroid function representation

This formula calculates a single numeric output by weighting each discrete value according to its degree of membership, resulting in an interpretable and precise outcome.

RESULTS

All the implementations, testing and control surfaces were carried out using MATLAB's Fuzzy software.

Fuzzy model

Figure 5. Rule viewer outputs for two different input profiles in the fuzzy inference system

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The fuzzy inference system modelled in this study is based on a set of if-then rules derived from the ANN based insights and experts' validations. In our case 81 decision rules are constructed, which combine all the different variables. An example of the rules extracted from the fuzzy model is presented in the figure 5.

After the definition of the rules, all the variables and outputs are to be scaled. Figure 6 presents the membership functions of the four different variables(D,SP,UC,F) and Figure presents the membership function for the output Entrepreneurial intention.

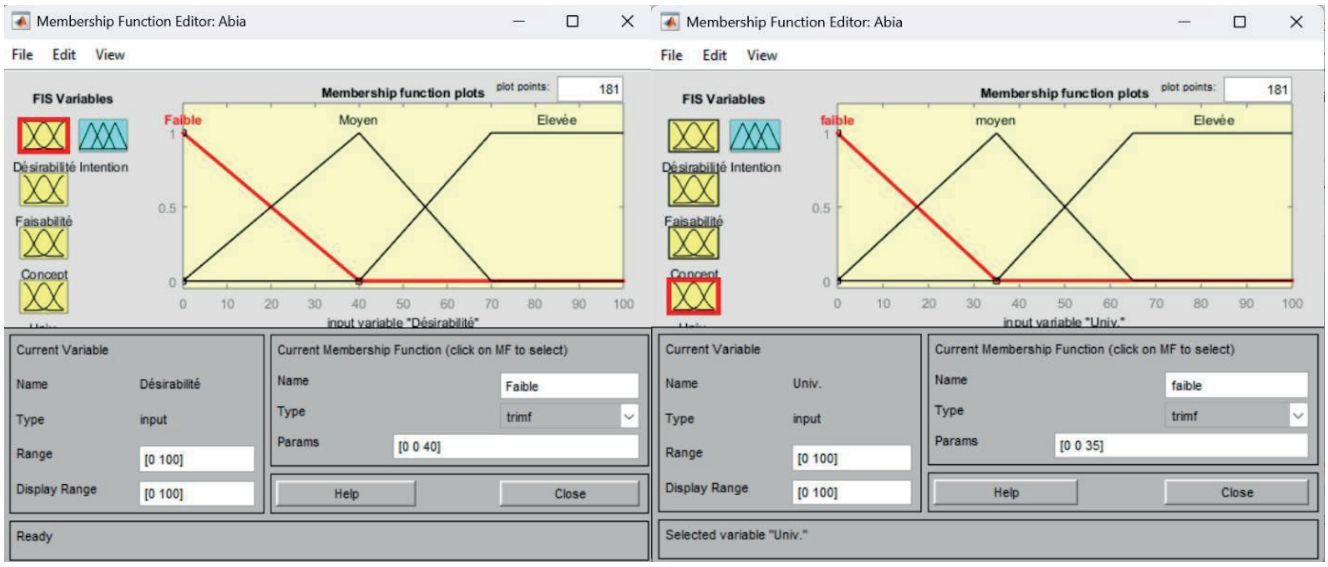

Figure 6. Membership Functions for the four input variables

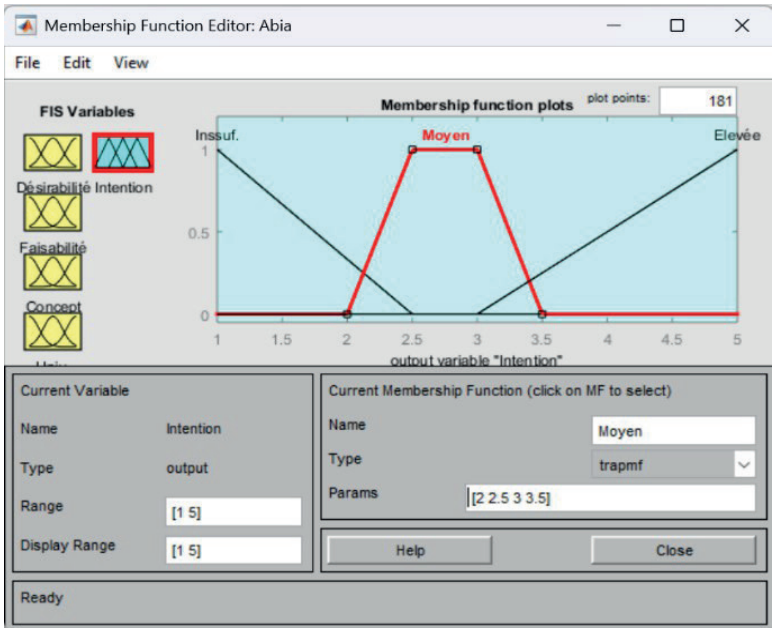

Figure 7. Output Membership function for Entrepreneurial Intention

The centroid method has provided a balanced aggregation of fuzzy outcomes into a crisp numerical value, facilitating easy interpretation and actionable insights. Ranges defined for Entrepreneurial Intention as presented in figure 7 are:

- Low (1,0 - 2,5)
- Moderate (2,5 - 3,5)
- High (3,5 - 5,0)

Surface Response Analysis

For an in-depth understanding of the interactions between the input variables and analyse the impact of the different factors on the entrepreneurial intention, the following plots were generated.

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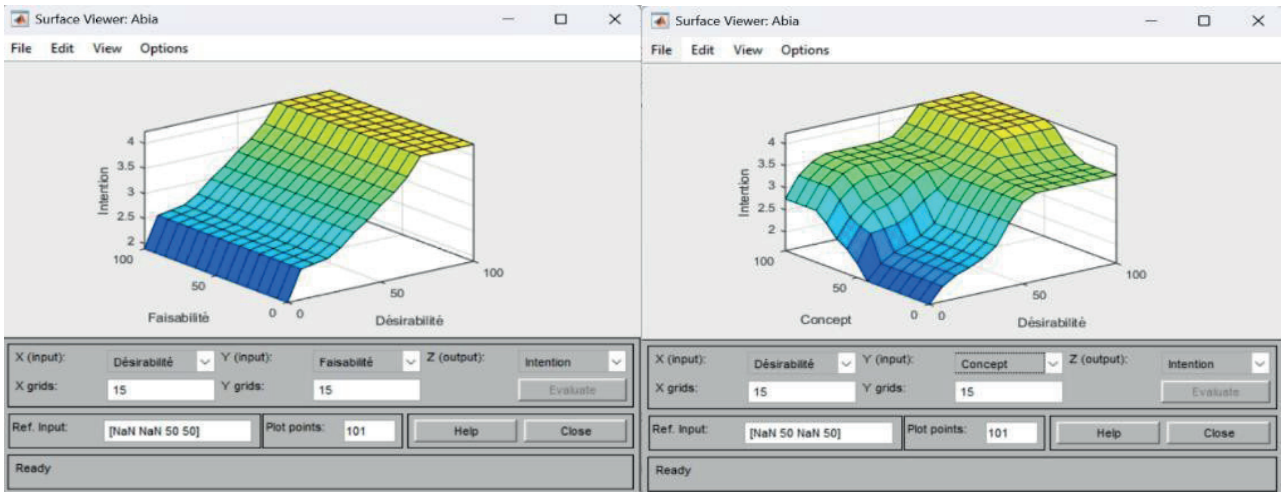

Figure 8. Surface plots of the fuzzy system for Entrepreneurial Intention

Figure 8 illustrates the relationship between desirability, self-concept and entrepreneurial intention. The model demonstrates how higher desirability and self-perception result in higher intention scores, and vice versa. This nonlinear nature highlights the ability of the fuzzy model to process the gradual variations of the intention levels. Higher desirability levels lead to a high intention regardless of university support or feasibility. The steep gradient suggests that university context plays a significant role only when desirability is already high. Overall, both desirability and self-concept have the strongest influence on entrepreneurial intention. Whereas university context and feasibility help strengthen the intention but do not compensate the low desirability or self-concept.

Validation of the Model

To assess a nd validate our model, considering experience validation reinforce the credibility of fuzzy logic,[63,64] we used a new dataset of 40 responses of the survey, where the fuzzy model computed the final EI score. Models. Table 4 presents a fragment of the computed scores for different scenarios. The outputs were then compared against the expected categories based on the experts' insights.

The results align with previous ANN model insights and confirms that higher desirability and self- concept have the strongest impact on students' entrepreneurial intention, whereas university context and feasibility remain as a supporting factor. The model successfully classified student's EI levels which aligns with the expert expectations and real-world patterns.

Key findings have shown that desirability and self-concept are the strongest predictors which is consistent with the ANN weightings. Hence high scores of the latter lead to high entrepreneurial intention values, confirming personal motivation is critical. Furthermore, low Desirability results in lo EI regardless of university context and feasibility scores. For instance, when both variables are high, such as in the cases with inputs (Desirability = 80, Self-Concept = 80) or (Desirability = 90, Self- Concept = 80). The model gives a high EI score (>4,0). Uniformly, low inputs consistently lead to low EI, validating the fuzzy rule behaviour. This suggests that external factors alone do not compensate for personal motivation and desirability, reinforcing the theoretical foundations of intention-based models such as the Theory of Planned Behaviour. For cases where values are moderately distributed across all variables, the model assigns moderate EI scores. Accordingly, the fuzzy rules and membership functions correctly provide stable results and consistent predictions with expert expectations.

The fuzzy logic model was tested with 40 new surveyed students' data. The resulting EI scores were analysed to assess the model's behaviour and have showed alignment with insights from expert's judgment and previous ANN-based findings. This confirmed the model's robustness in classifying students' profiles.

Table 4. Sample of computed EI scores from the new survey dataset using the fuzzy model

Desirability Score	Feasibility Score	Self-Concept Score	University Context score	EI
40	30	20	20	2,25
50	20	15	15	2,78
70	30	20	20	3,5
30	30	20	20	2,25
20	60	20	50	2,19

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20	20	40	10	2,19
20	20	20	50	2,19
20	20	20	20	2,19
50	50	50	50	3,43
10	10	10	10	1,91
15	10	10	40	1,98
10	15	10	40	1,96
80	15	80	40	4,26
80	40	10	10	3,19
15	80	60	60	2,88
20	70	70	60	3,33
25	45	20	20	2,25
45	30	20	20	2,63
90	30	20	20	3,5
90	30	80	40	4,33
15	15	40	40	2,07

Recommendation System

The model provides practical implications for institutions, inciting a better focus on boosting the student's motivation and confidence in entrepreneurial career, as well as strengthening their curricula and mentorship programs to support the students.

The main objective of this study was to construct a fuzzy-based recommendation system that provides a tailored guidance for both students and the university. For this purpose, the model's outputs and classification are used to give personalised recommendations and actionable suggestions.

The recommendation system has three key phases:

- Profiling the student: where the student takes the self-assessment survey
- Fuzzy logic processing and classification: the results from the survey are then pre-processed and inserted as input into the fuzzy model where a final EI score is generated
- Personalised recommendations: the system then provides a tailored recommendations constructed by experts based on the different levels of entrepreneurial readiness of the student. Moreover, the system presents the university with a guidance for each category in order to adapt their strategies with the entrepreneurial behaviour of the students.

The recommendation system aims to translate the outputs of the fuzzy model in actionable guidance for both students and universities. The recommendations are adapted to the student's specific profile as well the specific observed need of the studies university and textile sector. Moreover, the recommendations are categorised, i.e. knowledge and training, soft skill development, mentorship) for better clarity and usability.

The following tables 5 and 6 present personalised recommendations adapted to different EI score (low, medium and high) aiming to guide the students and institutions in strengthening their entrepreneurial readiness.

Recommendations for students

Table 5. Recommendation for students

EI Score	Entrepreneurial Readiness Level	Recommended Actions
1 - 2,5 (Low)	Students need Entrepreneurial Awareness	Knowledge and training: Take foundational entrepreneurial courses. Participate in entrepreneurship workshops and seminars Soft Skill Development: Strengthen self-confidence, Foster resilient mindset, and creativity. Exposure and engagement Learn from real-world business founders through guest lectures and networking.
2,5 – 3,5 (Medium)	Students are developing Entrepreneurial Skills	Entrepreneurship Skill-Building: Take in-depth courses on business strategy, finance, and leadership. Cultivate risk-taking and decision-making abilities Participate in Hands-On Business Simulations:

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		Engage in entrepreneurship case studies, hackathons, and startup competitions. Practical exposure through Startup internships Joint early-stage companies rp observe and apply your knowledge in dynamic environments Gain real-world exposure before launching a business.
3,5 - 5 (High)	Students are ready for Entrepreneurship	Join an incubator or accelerator program Programs that provide expert guidance, workspace, resources, and access to early funding for business development Mentorship & networking Engagement Connect with industry leaders and experienced entrepreneurs. Participate in startup competitions Scale up the business idea Access to Funding: Apply for startup grants through university entrepreneurship funds governments initiatives or investment platforms Intrapreneurial pathway Explore intrapreneurial opportunities Lead innovation projects or new business ideas within an existing company

Recommendations for Universities

Table 6. Recommendation for universities

EI Level of Students	University Support Strategies
Low (1-2,5)	Curriculum integration and real-world exposure Introduce Foundational entrepreneurship courses into the curriculum. Develop entrepreneurial related skills Organize guest lectures by successful entrepreneurs.
Medium (2,5-3,5)	Targeted training and courses Integrate advanced specialized entrepreneurship modules Provide access to business development workshops. Support Entrepreneurship-Focused Student Clubs Incubation and mentorship Develop university-led incubation programs. Establish mentorship connections and programs with alumni entrepreneurs. Offer career coaching focused on entrepreneurial careers (through the school's career centre)
High (3,5-5)	Startup Support Programs Facilitate venture capital & funding opportunities. Support startups with workspace & legal consulting. Provide seed funding, mentorship, and incubation support Create dedicated innovation spaces where students can prototype and test ideas. Industry collaboration Establish Partnerships with Industry Leaders Partner with industry leaders for innovation-driven projects Offer hybrid roles combining employment and entrepreneurship to ease the transition (intrapreneurship)

This recommendation system showcases dual benefit for both individual guidance and strategic planning. Moreover, the fuzzy logic model ensures that the categorisation of the students profiles is more nuanced and support personalised programs rather than a one size fit all program.

CONCLUSIONS

This study presents a hybrid decision-support framework that combines artificial neural networks and fuzzy logic to assess entrepreneurial intention among Moroccan university students in the textile sector. By translating complex behavioural data into interpretable decision rules, the model facilitates a clear categorization of entrepreneurial profiles. It also serves as the foundation for a recommendation system that guides students and institutions toward targeted entrepreneurial or intrapreneurial pathways.

Future work will enhance this system by integrating machine learning techniques to automate rule generation and enable adaptive, real-time recommendations. This dynamic approach could track the evolution of students' entrepreneurial mindsets over time, providing more personalized and continuous support for career development.

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