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ORIGINAL

Modeling Entrepreneurial Intentions in Moroccan Higher Education: Bridging Academia and Entrepreneurship with Artificial Neural Networks

Modelización de las intenciones empresariales en la enseñanza superior marroquí: Tendiendo puentes entre el mundo académico y el empresarial con redes neuronales artificiales

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ABSTRACT

This study explores the determinants influencing entrepreneurial intentions among higher education students in Morocco, utilizing both traditional statistical methods and Artificial Neural Networks (ANN) to predict entrepreneurial intention. The research focuses on variables such as desirability, social norms, self-concept, and academic context, and assesses their impact on students' propensity toward entrepreneurship. A survey was conducted with 300 engineering and master's students from Higher School of Textile and Clothing Industries (ESITH) in Casablanca.

The statistical analysis revealed significant relationships between entrepreneurial intention and factors such as desirability, social norms, and self-concept, while the feasibility factor showed a limited influence. ANN was employed to model the complex, non-linear relationships between these variables, providing deeper insights into the predictive dynamics of entrepreneurial intentions. The ANN model demonstrated high accuracy, highlighting the importance of desirability and social norms as primary drivers, followed by self-concept and academic context.

The study concludes with recommendations to enhance entrepreneurial intention through targeted educational strategies, emphasizing the role of practical experiences and skill-building programs. This research contributes a novel approach to understanding and fostering entrepreneurship in academic settings through the integration of ANN, offering predictive modeling capabilities that could inform future educational policies and entrepreneurial programs.

Keywords: Intention; Entrepreneurship; Intentional Model; Feasibility; Desirability; Social Norms, Artificial Neural Networks.

RESUMEN

Este estudio explora qué factores influyen en las intenciones emprendedoras de los estudiantes universitarios en Marruecos. Para ello, se utilizaron tanto métodos estadísticos tradicionales como redes neuronales artificiales (RNA), con el objetivo de predecir estas intenciones. La investigación analizó aspectos como la deseabilidad, las normas sociales, el autoconcepto y el entorno académico, evaluando cómo impactan en la inclinación de los estudiantes hacia el emprendimiento. Para recopilar datos, se encuestó a 300 estudiantes de ingeniería y máster de la ESITH (Escuela Superior de la Industrias de Textil y Vestimentas) en Casablanca. Los resultados del análisis estadístico mostraron que variables como la deseabilidad, las normas sociales y el autoconcepto están significativamente relacionadas con las intenciones emprendedoras, mientras que

la viabilidad tuvo un impacto menor. Por otro lado, el modelo de RNA permitió identificar conexiones más complejas y no lineales entre las variables, ofreciendo una perspectiva más profunda sobre las dinámicas que predicen dichas intenciones. Este modelo corroboró que la deseabilidad y las normas sociales son los factores clave, seguidos por el autoconcepto y el entorno académico.
En definitiva, el estudio propone implementar estrategias educativas diseñadas específicamente para fomentar el espíritu emprendedor. Destaca, además, la importancia de incluir experiencias prácticas y programas de desarrollo de habilidades. Al integrar las RNA en este análisis, el trabajo aporta un enfoque novedoso y herramientas predictivas útiles para diseñar programas educativos orientados al emprendimiento.

Palabras clave : Intención; Emprendimiento; Modelo Intencional; Viabilidad; Deseabilidad; Normas Sociales; Redes Neuronales Artificiales.

INTRODUCTION

Recently, the global vision has been shifting towards an entrepreneurial mindset that plays a crucial role in the transition of modern economies and societies.[1,2] In this context, Morocco is actively developing key economic initiatives across all sectors to guide the country towards the status of a high-income industrialized nation.

The launch of the industrial Acceleration plan is set to revitalize the Moroccan industry in the coming years. This plan aims to attract investments, create new jobs, and reduce the unemployment rate, especially among young graduates.[3] Statistics from the High Commission for Planning reveal that the youth unemployment rate is around 20 %.[4]

To address this challenge, Morocco has implemented policies to encourage entrepreneurship among the general population, particularly young graduates. Youth entrepreneurship is crucial for improving graduate employability, as research indicates that entrepreneurship is a popular career choice for students worldwide. Today, this entrepreneurial ambition has become a major issue for most countries because of its ability to trigger economic growth and create job opportunities.[5]

The key question is: how can we bridge that gap between academic training and the entrepreneurial world for students? It is essential to support young people's entrepreneurial intentions, as these are often the precursors to entrepreneurial actions. Regular and targeted training sessions, alongside supportive policies, can strengthen these intentions.

Aware of the country's new economic and social situation, Moroccan universities have turned their attention to supporting entrepreneurial projects.[6,7] As Kawter et al.[8] pointed out in their review of the current situation and the scope of university entrepreneurship in the Moroccan context: "Universities can play the entrepreneurship card by stepping up their entrepreneurial activities (taking stakes in public and private companies; creating subsidiary companies; setting up public interest groups)".

Similarly, for Gibb et al.[9] universities should encourage students to consider entrepreneurship as a career choice.

The Moroccan government has placed a strong emphasis on entrepreneurship education.[10] Programs like the CLE entrepreneurship program at Mohamed V University in Rabat, which aims to develop students' entrepreneurial spirit and skills , and the student 'Up program, organised by the European Union in collaboration with Morocco.[11] In addition to the establishment of Morocco's first startup incubation canter, Startup Square highlights the country's commitment to fostering entrepreneurship.

Entrepreneurial intentions can be influenced by various factors, which vary according to individual, social, cultural, and environmental contexts. Understanding the entrepreneurial motivations of Moroccan students if therefore essential.

Most literature is based on Ajzen's (1991) theory of planned behavior, which focuses on intention as the primary driver of human actions, considering three factors: attitude towards behavior, social norm, and perceived behavioral control.

- Attitude towards entrepreneurial behavior: this refers to an individual's perception of the desirability of starting a business.[12]
- Social norm: this reflects the influence of social pressure or the surrounding environment to become an entrepreneur.[13]
- Perceived behavioral control: this relates to an individual's confidence in their ability to carry out the necessary actions to start a business.[14]

These interconnected factors play a key role in the decision to pursue an entrepreneurial career. In research on entrepreneurial intention, various analytical methods have been used to examine influencing factors. Classical statistical methods, like linear regression analysis, and correlations, have been employed to highlight

interactions between independent variables (desirability, feasibility, self-concept, and academic context) and entrepreneurial intentions.[9]

The link between these factors and the ability to make the decision to become an entrepreneur is complex, as decision-making involves a process of intellectual and psychological transformation. However, due to the excessive complexity of the classical model, the parameters are difficult to estimate, particularly when it comes to capturing linear or non-linear relationships between factors, which makes its practical application difficult. Consequently, it is essential to determine whether the main factors influencing entrepreneurial intention interact in a linear or non-linear way to orient the mind towards the entrepreneurial world. Current research aims to establish a linear and non-linear model between factors and entrepreneurial intention. Artificial neural networks (ANNs), a branch of AI, are models inspired by the workings of the human brain. They are particularly useful for detecting complex, non-linear and multidimensional relationships between data. In the context of entrepreneurship, artificial neural networks can provide deeper insights into how different factors interact to influence entrepreneurial intentions.

Research in the field has paid little attention to this method due to its complexity. This lack of research hinders the creation of an in-depth study system to determine the impact on intention. To overcome the limitations of conventional techniques and to provide a more in-depth analysis, this study uses artificial neural networks to analyze the data collected, in addition to conventional methods.

Literature review

Notion of entrepreneurship

Before looking at the phenomenon of intention and the determining factors favoring the development of entrepreneurship and the entrepreneurial spirit in engineering schools, we need to go back over the definitions of entrepreneurship in the literature.

According to Laviolette et al entrepreneurship is defined as the dynamic process of creating and exploiting a business opportunity by one or more individuals, leading to the creation of new organizations to generate value.[15] The entrepreneur must be able to design products or services, evaluate the various business functions, understand the industry and its trends, motivate staff, create influential relationships within the business network, plan and manage business activities, and establish opportunities.

In another approach, Kawter R et al.[16] points out that entrepreneurship derives from the Anglo-Saxon concept of “entrepreneurship”, which means the action of creating wealth or employment in a nation, either by setting up a new business or by taking over a failing one. [14] Simply put, entrepreneurship is the willingness, ability, and action to undertake.

For his part, Filion LJ[17] highlights a more operational vision of the entrepreneur, particularly among engineers and operations management specialists, where the entrepreneur is seen as an expert in the allocation and coordination of resources.

The notion of intention

Entrepreneurial intention is the first stage in the entrepreneurial process. It expresses a person’s drive to create their own business and can be explained by the personal characteristics of potential entrepreneurs, their environmental situation, and their cultural characteristics.

Most researchers working in the field of business creation agree on the importance of intention in the entrepreneurial process. For Maroua Zineelabidine et al.[18] intention is an important step in the entrepreneurial process. The study of business creation behavior is intimately linked, if not inseparable, from intention: «The intentional approach represents the crossroads of different approaches to the entrepreneurial field, making it possible to describe in depth the phenomenon of the entrepreneurial act and its antecedents, in an attempt to understand and explain it ».

Even if intention can evolve differently from one person to another, for Boudabbous S[19] it remains the only and best predictor of entrepreneurial behavior, especially in the case of intentional, planned, and goal-oriented behavior.

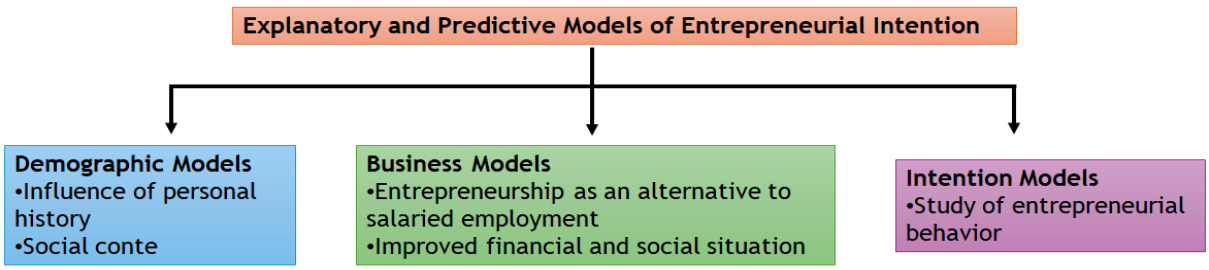

Figure 1. Explanatory and Predictive Models of Entrepreneurial Intention

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Several explanatory and predictive models of entrepreneurial intention have been proposed in the literature (figure 1). These models are best suited to predicting entrepreneurial behavior. They are based on the idea that any intentional behavior can be anticipated by the intention to adopt it. So, behind every entrepreneurial act, there is first and foremost an entrepreneurial intention.

Study of theoretical models

According to Maroua Zineelabidine et al.[18] contextual variables have a considerable influence on individuals' entrepreneurial intentions. The study of entrepreneurial intention is crucial insofar as it makes it possible to determine the intermediary variables that explain the act of entrepreneurship.

From this perspective, students' entrepreneurial intentions depend on several social, psychological, and environmental variables. It draws its sources from several theories, especially Ajzen's theory of planned behavior, which attempted to model the individual's intention to undertake[20] making his theory essential to the study of entrepreneurial intention.

Ajzen's theory of planned behavior

"Theory of Planned Behavior" or TCP is one of the most widely used theories in the literature in terms of explaining and predicting "individual behavior". It has been systematically used to understand intention and interpret behavior in various fields of research.

The "Theory of Planned Behavior" (TPB) holds that a person's intention is a major factor requiring a certain amount of organization and planning (such as starting a business). The interest and strength of TCP lies in its use in all studies where behavior is intentional.

For TCP, intention emanates from three essential determinants (figure 2):

- Attitude towards behavior: represents the degree of positive or negative evaluation a person makes of a given behavior.
- Subjective norms: refer to the social norms perceived by an individual in the event of performance or non-performance of the behavior in question. In other words, his or her attitude towards how others perceive this behavior. The latter are often family members, friends, work colleagues or any other person close to the individual.
- Perceived behavioral control corresponds to the perceived ease or difficulty of performing a behavior. It corresponds to the personal perception of the feasibility of the behavior concerned.

The first two elements contribute to the attractiveness of the behavior and can be likened to the notion of desirability found in Shapero's work on entrepreneurship.

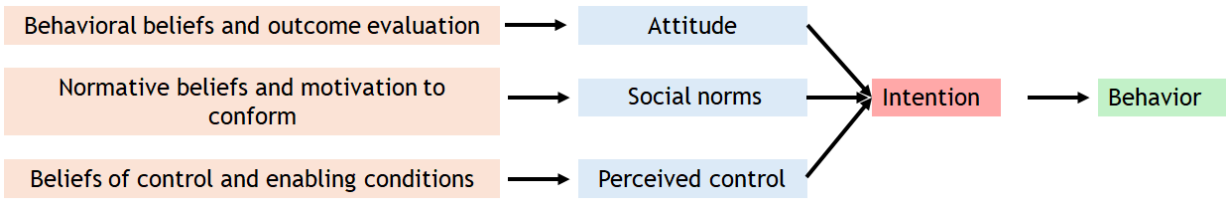

Figure 2. Ajzen model (1991)

One of the most widely used theories to explain the entrepreneurial process via entrepreneurial intention is the "theory of planned behavior".[20] However, it has been the subject of much criticism. Some researchers claim that it is based on cognitive processing only, i.e. it ignores the individual's needs before executing a given action. These needs affect his behavior, whatever his attitudes Furthermore, it does not take into account the individual's emotional aspects when making decisions, even though these can be very influential on his behavior.[19]

Shapero and Sokol theory (1982)

The oldest and best-known model of entrepreneurship.[22] The model has been modified several times, notably by a study.[23] It describes the determinants of the choice of an entrepreneurial career as an alternative to another career path based on:

- Perceived desirability, which represents the individual's attraction to entrepreneurship and the entrepreneurial act. It is closely linked to the attitudes and subjective norms presented in Ajzen's TCP.[24] It is of course influenced by various socio-cultural factors.
- Feasibility derives from the individual's perception of his or her skills as indispensable for entrepreneurship. It is linked to Ajzen's variable of perceived behavioral control, as they both focus on assessing a person's ability to engage in a successful entrepreneurial process.

It should be noted that individuals may judge an action as desirable but not feasible, and feasibility affects desirability. Indeed, perceptions of desirability and perceptions of feasibility interact. However, for pedagogical reasons, Shapero & Sokol treat the two factors separately (figure 3).

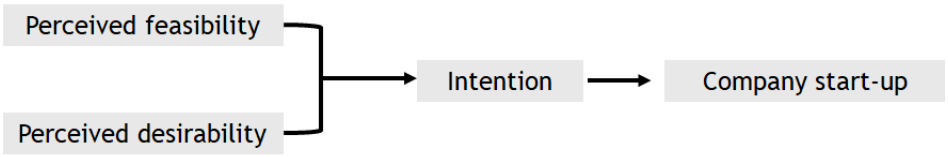

Figure 3. Model by a. Shapero and Sokol (1982)

Ajzen's (1991) perceived behavioral control is similar to the feasibility factor in that it refers to an individual's belief in his or her ability to accomplish a given task. Furthermore, the attitudes and social norms proposed in Ajzen's (1991) model refer to the concept of desirability.

The Shapero model after Krueger (1993)

Krueger has taken up Shapero's model by adding and completing the entrepreneurial intention model as shown in figure 4 below: [23]

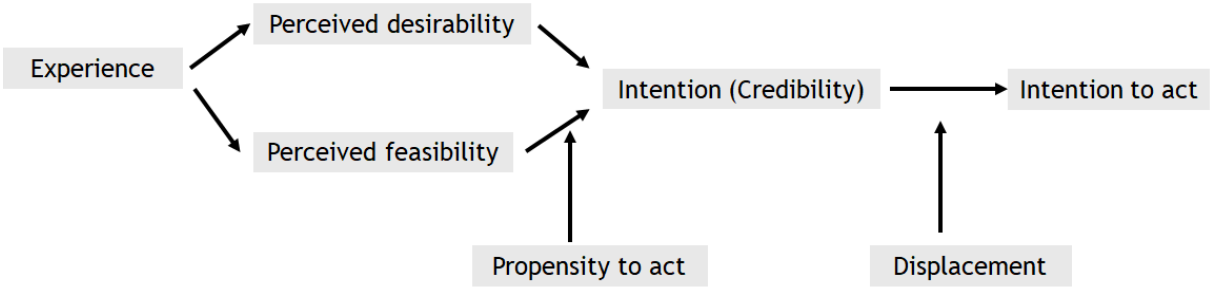

Figure 4. Shapero model after Krueger (1993)

Desirability represents the attractiveness of entrepreneurship and the entrepreneurial act. It is strongly linked to the attitudes and subjective norms presented in TCP of Ajzen.[23] It is of course influenced by various socio-cultural factors.

Feasibility derives from the individual's perception of his or her skills, which are indispensable for entrepreneurship. It is linked to Ajzen's attitude variable (perceived behavioral control), as they both focus on a person's ability to engage in a successful entrepreneurial process.

Psychological disposition is an individual's propensity to act. The move represents an event that can occur in positive situations, such as an opportunity to start a business, or negative situations, such as being unemployed, or neutral situations, such as graduation. Contrary to Ajzen's "Theory of Planned Behavior", for an individual to make a career change, an event must trigger such a decision. This situation therefore leads to a shift.

In the intentional model, the place occupied by social norms is not very precise. In Shapero-Krueger's concept, it is only a component of perceived desirability, whereas in Ajzen's model, it is an independent variable that directly affects intention.

Choice of the appropriate theoretical framework for the study

It seems appropriate to draw inspiration from the "formation of the entrepreneurial event" and "theory of planned behavior" models, which have so far served as guides to understanding entrepreneurial intentions in academia. These two models, which form the basis of our thinking, share common features that allow them to be combined, as evidenced by several studies.[16,19,21,25]

Tatiana Iakovleva examined in her work whether the theory of planned behavior (Ajzen, 1991) and the entrepreneurial event model can be combined into a single model of entrepreneurial intentions.[20,22,26] Results from 324 Russian university students indicate that the two intention models can be successfully integrated into one, where attitude, subjective norm, and perceived behavioral control determine desirability-feasibility, which in turn determines intentions. Personal experience, cultural context, and external triggers, such as economic opportunities, reinforce these intentions and increase the predictive power of the combined model.

However, our research goes beyond this simple combination. By analyzing the determinants of these models and identifying their similarities, we were able to develop a new model for measuring entrepreneurial intention. This model incorporates not only traditional factors but also elements specific to the Moroccan context, such as the "university context" and "self-concept". These additional factors are linked to "propensity to act"

and "displacement" respectively, enriching our understanding of the mechanisms underlying entrepreneurial intention.

Table 1 presents the determinants of these models and their similarities, as well as the determinants retained in our new model. By focusing on Moroccan students, our study highlights the importance of these additional factors and their impact on entrepreneurial intention.

Table 1. Comparative study of the present work with the chosen model

Ajzen (1991)	Shapero and Sokol (1982)	Shapero after Krueger (1993)	This Study
Behaviors	Desirability	Desirability	Desirability
Social standards			Social standards
Perceived control	Feasibility	Feasibility	Feasibility
		Psychological disposition (propensity to act)	Concept de soi
		The university context	Negative, positive or intermediate displacement

METHOD

Working environment

The survey was carried out on a population of 300 ESITH engineering and master's students over 3 months in 2023. The results from these students should provide a better understanding of the determinants of intention so that the actions needed to improve it can be implemented at ESITH level.

Explanatory model of entrepreneurial intention

Table 2. Variable measurement structure

	Variable name	Number of items
Dependent variables	Intention	2
Independent variables	Desirability and social norms	9
	Feasibility	6
	Self-concept	12
	The university context	6

We selected 35 items from the questionnaire to explain the entrepreneurial intention of ESITH students. Almost all of them were captured on 5-point Likert scales.

The 5-point Likert scale is a very useful tool for measuring attitudes, opinions or perceptions. It consists of a series of statements or questions to which participants respond by choosing one of five levels of agreement or disagreement. Participants' answers are numerically coded to enable quantitative data analysis. The model presents 5 main variables that we have tried to explain (table 2).

Collecting information

For this study, a quantitative research approach was adopted, based exclusively on data collection via a questionnaire distributed to students. Table 4 lists the questions that were submitted to the target students via a questionnaire (Abia enquête 2023). These questions or items are presented in such a way as to show the link between the dependent and independent variables and the variables in our explanatory model of entrepreneurial intention.

RESULTS AND DISCUSSION

Sample analysis and descriptive results

The study was based on a survey of ESITH engineering and master's students. The target population was approximately 300 students. 191 students responded to the questionnaire.

The breakdown of the population in terms of age and gender is presented in figure 5:

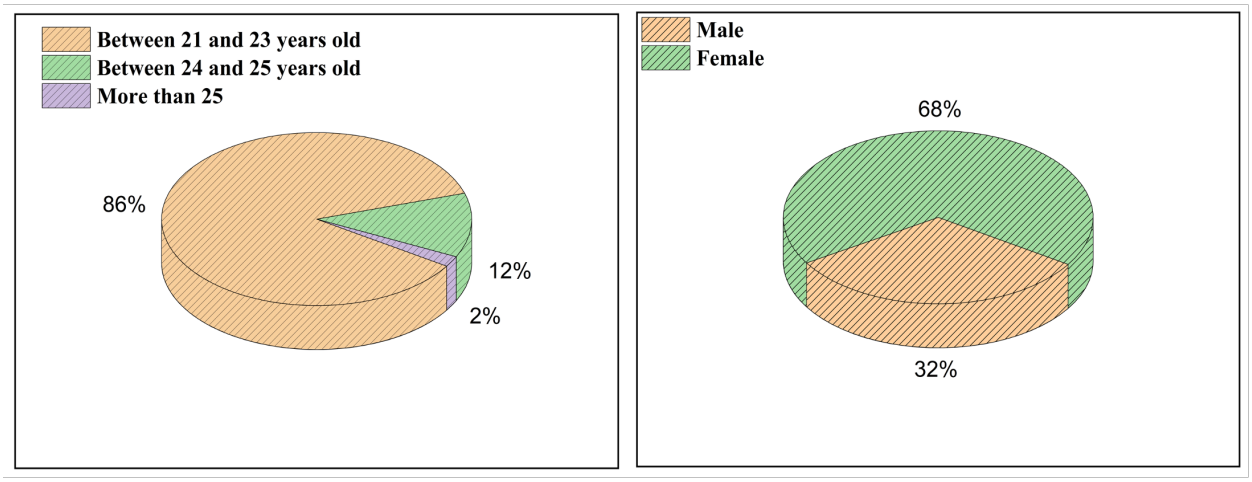

Figure 5. Population distribution by age and gender

To assess students' entrepreneurial intentions, we posed several questions, the details of which are provided in the supplementary information (Table S1). The first question asked was: "After your studies, do you plan to start or take over a business?" The results revealed that 49,74 % of respondents answered, "I will do everything I can to start and run my own business," while 29,84 % indicated "I have very seriously considered starting a business." This demonstrates a strong entrepreneurial intention within the survey sample (table 3). The second question, "If so, when do you plan to start your own business?" showed that 32,46 % of participants plan to do so 3 to 5 years after graduation, and 21,47 % indicated they would wait more than 5 years after graduation (table 4)

Table 3. Questionnaire results variable Intention

Are you planning to set up or take over a business when you finish your studies?	Total (%)
Not my objective Professional	1,57
I don't know, I haven't thought about it yet.	18,85
I've been thinking very seriously about starting a business	29,84
I'm going to do everything I can to start and run my own business	49,74
Overall total	100,00

The descriptive analysis of the questionnaire responses, relative to the independent variables shows the following results, based on students with a strong entrepreneurial intention, in percentage of very favorable or strongly agree opinions with the question:

For the "Desirability and social norms" variable

Table 4. Desirability and social norms questionnaire results.

If I have the opportunity and the resources, I'll start a business.	61,07 %
A career as an entrepreneur is attractive to me	61,29 %
Is your family environment conducive to entrepreneurship?	63,75 %
Greater job security: What are the main reasons you would like to start your own business?	63,38 %
Gagner mieux sa vie: What are the main reasons you would like to start your own business?	54,62 %
Gain recognition and a better social position: What are the main reasons you would like to start your own business?	53,85 %
Better working conditions: What are the main reasons you would like to start your own business?	53,39 %
Encouragement from friends and family? What motivates or could motivate your commitment to entrepreneurship?	59,70 %
My personal constraints and commitments (family and others)? What's the biggest obstacle to going into business for you?	56,52 %

"Family environment" and 'better job security' are the most cited in 'Desirability and social norms', with 63 % in favor.

For the "Feasibility" variable

Table 5 illustrates the results relating to the perceived feasibility of the entrepreneurial project among students. These data make it possible to identify the main motivating factors as well as perceived obstacles, such as financial resources, administrative constraints, and financial risks, influencing their potential commitment to business creation. The results show that 74,07 % of students consider that administrative constraints (laws, regulations, procedures, etc.) are an obstacle to entrepreneurship, and this result is by far the main concern in terms of feasibility.

Table 5. Results of the feasibility questionnaire

Opportunity, a favourable environment, a winning idea? What motivates or could motivate your commitment to entrepreneurship?	51,69 %
Financial resources, sources of finance and support from banks? What motivates or could motivate your commitment to entrepreneurship?	55,17 %
My financial resources and start-up capital: What are the main obstacles or disincentives for you in setting up your own business?	53,19 %
Administrative constraints (laws, regulations, procedures, etc.): What do you see as the main obstacle to going into business?	74,07 %
Limited material resources (premises, machinery, etc.): What do you see as the main obstacle to going into business?	51,92 %
Financial risks in the event of failure: What do you see as the biggest obstacle to going into business?	49,18 %

For the 'Self-concept' variable

Table 6. Self-concept questionnaire results

Creativity: Do you think you have a satisfactory level of the following abilities to become an entrepreneur?	59,76 %
Leadership and communication: Do you think you have a satisfactory level of the following skills to become an entrepreneur?	55,13 %
Do you think it's easy to become an entrepreneur as a student or just after your studies?	100,00 %
I think setting up a business is very risky?	51,16 %
I'd rather stay in paid employment: What do you see as the biggest obstacle to going into business?	42,86 %
Overcoming personal challenges: What are the main reasons you would like to start your own business?	55,88 %
To be able to do and practise an activity of your choice and that you enjoy: What are the main reasons you would like to start your own business?	55,28 %
Being free to make your own choices: What are the main reasons you would like to start your own business?	57,63 %
Being autonomous in your work: What are the main reasons you would like to start your own business?	55,93 %
Belonging to a recognised social group: What are the main reasons you would like to start your own business?	49,02 %
Your personality, your entrepreneurial temperament? What motivates or could motivate your commitment to entrepreneurship?	65,06 %
My personality (cautious, hesitant, unadventurous, etc.): What's the main obstacle to starting your own business?	40,00 %

Table 6 presents the results relating to students' self-concept, highlighting their perception of skills such as creativity, leadership, and communication, as well as their view of the risks and rewards of entrepreneurship. This information makes it possible to assess the extent to which self-confidence and personal motivations influence their intention to set up a business.

For the 'self-concept' variable, all the students think that 'it's easy to become an entrepreneur when you're a student or just after your studies', and their personality and entrepreneurial temperament motivate them strongly. This shows that self-concept is very high in this generation of students.

For the "University context" variable

Table 7 presents the results relating to the university context in students' entrepreneurial intention. It highlights their level of familiarity with the entrepreneurial process, the influence of interactions with teachers,

and the role of training and academic support. These elements shed light on the impact of the university environment on motivation and perceived obstacles to entrepreneurship.

The results show that accompaniment, coaching, and training received are the main sources of motivation for a commitment to entrepreneurship, with 60 % of respondents 'completely agreeing'.

Table 7. Questionnaire results University context

I'm familiar with the practicalities of setting up a business	58 %
The interaction with my teachers has enabled me to adopt new entrepreneurial models and to think about taking more risks in my business start-up project.	58 %
My university career: What do you think are the main reasons for going into business for yourself?	57 %
Companionship, coaching: What motivates or could motivate your commitment to entrepreneurship?	60 %
Training and awareness at my school? What motivates or could motivate your commitment to entrepreneurship?	61 %
Lack of knowledge and skills in entrepreneurship, lack of support? What is the main obstacle to starting your own business?	51 %

Statistical analysis

A qualitative statistical study using a contingency Chi-square (x^2) test was carried out to measure the dependence or otherwise of the variables. In other words, it is used to determine whether there is a significant relationship between two categorical variables. To perform the contingency chi-square test, we organize the data in the form of a cross-tabulated table, also known as a contingency table. This table shows the observed frequencies for each combination of categories of the two variables. We then calculate a statistic called x^2 from this table. The higher the value of this statistic, the more likely it is that the variables are not independent. Finally, this value is compared to a critical x^2 value. If the observed value is greater than the critical value, we can conclude that the variables are significantly related.

For the dependent variable Intention the results, on the 5-point Likert scale, showed that the variable has 4 modalities:

Mode 1: mean between 1 and 2 (2 excluded) with 3 students.

Mode 2: average between 2 and 3 (3 excluded) with 31 students.

Mode 3: average between 3 and 4 (4 excluded) with 67 students.

Mode 4: average between 4 and 5 (5 included) with 90 students.

Modality 1 was merged with modality 2 given the low number of responses (only 3 students).

The same reasoning was used for the independent variables.

The results are summarized as follows: Table 8 shows a significant dependence between "Intention" and "Desirability and Social Norms" (x^2 = 19,178, p = 6,847´10-5), supporting Hypothesis 1. The attraction analysis shows that Desirability modality 3 and Social Norms modality 3 are associated with Intention modalities 2 and 3, while Desirability modality 4 aligns with Intention modality 4. These findings suggest that higher levels of desirability and social norms are linked to stronger entrepreneurial intentions.

Table 8. Results Desirability and social norms

Desirability and social standards
Data: intention / desirability and social standards
X-squared = 19,178, df = 2, p-value = 6,847e-05

	Modality		3	4	Total
Intention	2	Employees	18	16	34
		Theoretical headcount	8,9	25,1	
	3	Employees	19	48	67
		Theoretical headcount	17,5	49,5	
	4	Employees	13	77	90
		Theoretical headcount	23,6	66,4	
	Total		50	141	191

Table 9 displays the relationship between "Intention" and "Self-Concept", revealing a similar dependency (x^2 = 28,095, p = 7,928´10-7), which supports Hypothesis 3. The attraction analysis indicates that Self-Concept

modality 3 is associated with Intention modalities 2 and 3, while Self-Concept modality 4 aligns with Intention modality 4. This suggests that a stronger self-concept corresponds with a higher level of entrepreneurial intention.

Finally, table 10 illustrates the dependency between "Intention" and the "University Context" (x^2 = 5,8009, p = 0,05), which supports Hypothesis 4. Together, these tables highlight the key relationships observed in the study. The attraction analysis shows that University Context modality 3 is associated with Intention modalities 2 and 3, while University Context modality 4 aligns with Intention modality 4. Together, these tables emphasize the key relationships observed in the study, highlighting how context, self-concept, desirability, and social norms influence entrepreneurial intention.

Hypothesis 1: desirability and social norms regarding entrepreneurial behavior have a positive and significant impact on students' entrepreneurial intention.

Hypothesis 2: the feasibility of entrepreneurial behavior has a positive and significant impact on students' entrepreneurial intention.

Feasibility

Data: INTENTION /La Faisabilité

X-squared = 2,0812, df = 2, p-value = 0,3532

Hypothesis 3: self-concept towards entrepreneurial behavior has a positive impact on students' entrepreneurial intention.

Table 9. Self-concept results

SELF-CONCEPT
Data: INTENTION and SELF-CONCEPT
X-squared = 28,095, df = 2, p-value = 7,928e-07

	Modality		**3**	**4**	**TOTAL**
Intention	2	Employees	28	6	34
		Theoretical headcount	17,3	16,7	
	3	Employees	40	27	67
		Theoretical headcount	34	33	
	4	Employees	29	61	90
		Theoretical headcount	45,7	44,3	
	Total		97	94	191

Table 10. Results University context

UNIVERSITY CONTEXT
Data: INTENTION and the UNIVERSITY CONTEXT
X-squared = 5,8009, df = 2, p-value = 0,05

	Modality		**3**	**4**	**TOTAL**
Intention	2	Employees	30	4	34
		Theoretical headcount	24,7	9,3	
	3	Employees	49	18	67
		Theoretical headcount	48,8	18,2	
	4	Employees	60	30	90
		Theoretical headcount	65,5	24,5	
	TOTAL		139	52	191

Hypothesis 4: the university context for entrepreneurial behavior has a positive impact on students' entrepreneurial intention.

The test showed a dependency between these two variables with a kie-deux coefficient equal to 5,8009 and a p-value of 0,05. Attraction analysis yielded:

Modality 3 of the University Context variable attracts modalities 2 and 3 of the intention variable.
Modality 4 of the University Context variable attracts modality 4 of the intention variable.

Regression on

A second study was carried out using linear regression. The results are presented in table 11 and 12.

Table 11. Linear regression study

Regression statistics	
Coefficient of multiple determination	0,44491386
Coefficient of determination R2	0,19794834
Coefficient of determination R^2	0,18069992
Standard error	0,71420778
Observations	191

Table 12. Linear regression study

	Coefficients	Standard.error	Statistics t	Probability
Constant	0,28727651	0,48412679	0,59339106	0,55364035
Desirability and social norms	0,25680314	0,12130298	2,11703905	0,03558581
Feasibility	0,06400002	0,09056293	0,70669114	0,48064279
Self-concept	0,47540961	0,11127019	4,27256935	3,0809E-05
The university context	0,07133964	0,09736867	0,73267549	0,46467868

This analysis highlights several interesting points. Firstly, the confirmation that the "Feasibility" variable does not influence intention, with a significance of 0,48 well above the 0,05 threshold. This result seems to run counter to certain theories and research findings, which consider that the perception of feasibility plays an important role in the formation of the intention to act. This may indicate that ESITH students do not necessarily perceive their ability to engage in entrepreneurship as a major obstacle, which may be linked to a lack of knowledge of entrepreneurial realities or overconfidence in their skills.

Secondly, the "university context" variable seems to have a limited influence. This suggests that the mere presence of programs dedicated to entrepreneurship remains insufficient to encourage students to become entrepreneurs. This is in line with several studies, which emphasize that theoretical training, without concrete practical implementation, has a limited impact on the development of entrepreneurial intentions. This situation may be linked to the way entrepreneurship is taught.

On the other hand, we can identify two statistically significant influence relationships at one level (0,035 and 3,08´10-5) with coefficients of (0,256 and 0,475) respectively. This suggests that "Desirability and social norms" and "Self-concept" each have a specific influence on the intention variable. These results are in line with the trend observed in several recent works, where Desirability and individual perceptions of self-play a major role in the formation of entrepreneurial intention.

Artificial neural network (ann) modeling and training

To evaluate entrepreneurial intention based on four main variables, Desirability, Feasibility, Self-concept, and Academic Context, an artificial neural network (ANN) was designed. The objective of this model is to predict a continuous output in the form of an entrepreneurial intention score, ranging between 0 and 1, representing levels from very low to very high entrepreneurial intent.

Model architecture

The input variables used in this model are relatively concrete and directly measurable, justifying a simplified architecture compared to more complex models handling abstract data. For instance:

- Desirability measures the attractiveness of entrepreneurship to an individual.
- Feasibility represents the individual's perceived ability to undertake entrepreneurship.
- Self-concept and Academic Context are also quantifiable and show fewer interdependencies than more abstract variables such as multiple intelligence forms.

This simplicity allows for a model with fewer hidden layers with 10, 20, and 15 neurons, respectively. ReLU activation functions are applied to the hidden layers, introducing non-linearity to capture potential interactions between variables.

https://doi.org/10.56294/dm2025722

The model's output layer contains a single neuron producing a continuous entrepreneurial intention score. Since this is a regression problem, no activation function is applied at the output layer.

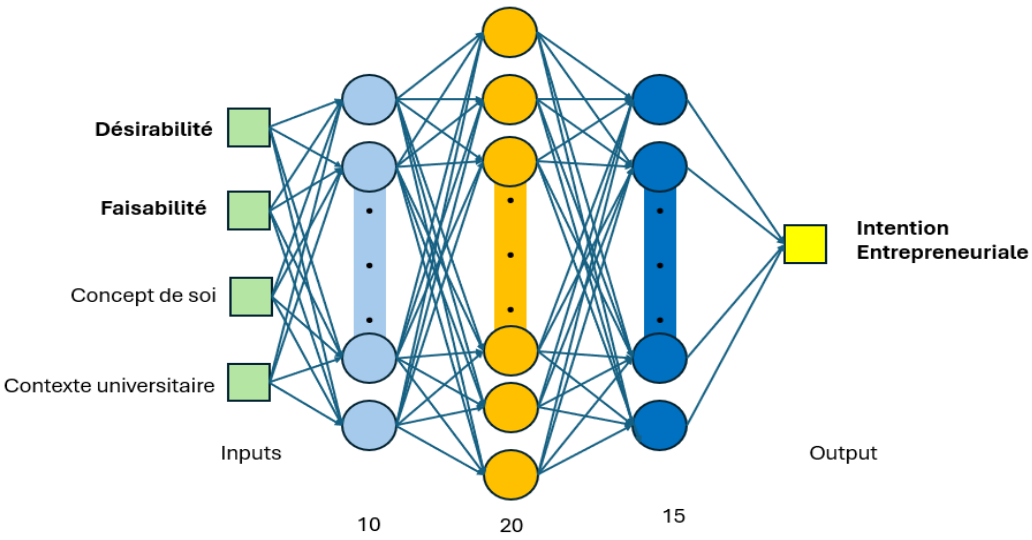

Figure 6. Artificial Neural Network Architecture

Data normalization

Input data were normalized using the min-max method, scaling all variables to a range of 0 to 1. This step ensures that all input variables have comparable scales, facilitating efficient model convergence during training. The normalization formula used is:

$$x' = \frac{x - x_{min}}{x_{max} - x_{min}}$$

Normalization ensures the model can process input variables effectively without bias from variables with higher magnitude.

Loss function and optimization algorithm

The Mean Squared Error (MSE) was chosen as the loss function due to its suitability for continuous regression problems. MSE is calculated as:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

Where:
yi is the actual value.
$\hat{y}_j$ is the predicted value.
n is the total number of samples.

The Adam optimizer was used for training the model. It combines the benefits of momentum and RMSProp optimization algorithms, ensuring efficient weight updates in multi-layer neural networks.

Training and validation

The dataset was split into:

- 70 % training data to learn relationships between input variables and the output.
- 30 % test data to validate the model's generalizability to unseen data.

This division minimizes overfitting, where the model becomes overly tailored to the training data and struggles with new inputs.

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Continuous output and variable relationships

The ANN predicts a continuous score, representing entrepreneurial intention on a scale of 0 to 1. This regression problem is less complex than classification problems, as it involves identifying linear or slightly non-linear relationships between input variables (e.g., Desirability, Feasibility) and the output. Consequently, fewer hidden layers suffice.

Furthermore, the relationships between the variables are generally direct and independent:

Greater desirability or perceived feasibility tends to directly increase entrepreneurial intention scores. Three hidden layers adequately capture the dynamics of these interactions

Model performance

Post-training, the model's performance was assessed using MSE, with a low value indicating strong alignment between predictions and actual data. Additional metrics like precision and R2 provide further insights into the model's overall accuracy and predictive capabilities.

Le modèle RNA, en intégrant la normalisation des données, une architecture à plusieurs couches et l'optimisation par l'algorithme Adam, a montré des résultats satisfaisants pour prédire l'intention entrepreneuriale en fonction des variables étudiées.

Results interpretation

Ann model performance

The graph below plots:

X-axis: Actual entrepreneurial intentions (normalized between 0 and 1).

Y-axis: ANN-predicted values.

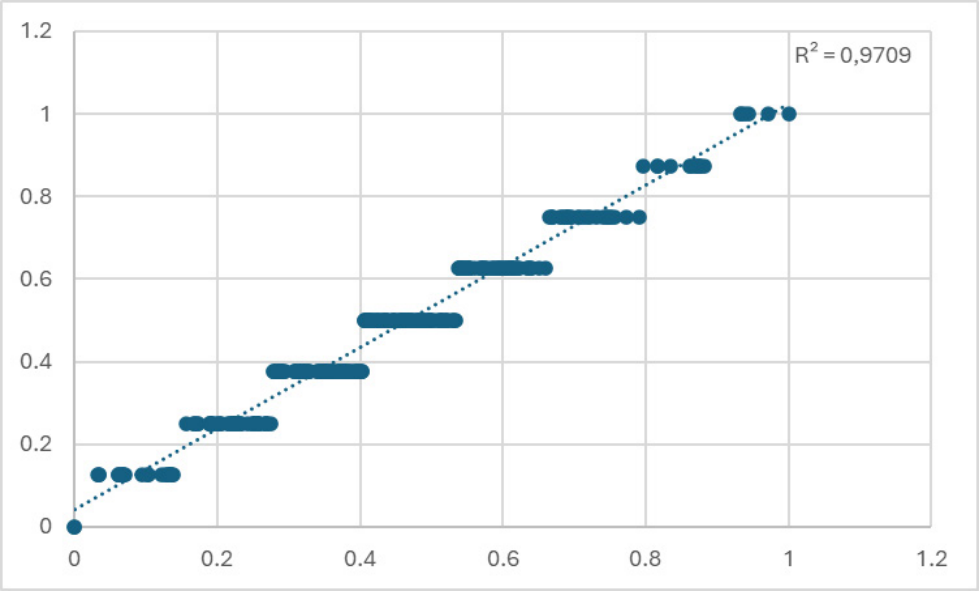

Figure 7. Correlation Between Predictions and Actual Entrepreneurial Intentions

The ANN achieved a low MSE of 0,024 and an R^2 coefficient exceeding 0,97, demonstrating strong correlations between predictions and actual values. These results suggest the model effectively captures students' entrepreneurial intentions.

Factors influencing entrepreneurial intention

- Desirability and social norms: this variable heavily influences entrepreneurial intention (40 %), capturing both personal attraction to entrepreneurship and social influence (family, friends, culture).
- Self-concept: perceived competencies like leadership and creativity significantly affect intentions (30 %), showing a direct link between self-confidence and entrepreneurial motivation.
- Academic context: this factor has a moderate influence (15 %), highlighting the role of institutional support and teacher interaction.
- Feasibility: with a lower weight (10 %), feasibility appears less critical, possibly due to students' overestimation of their abilities or underappreciation of practical challenges.

Impact and influence on entrepreneurial intention

The ANN identifies the following degrees of influence:

- Desirability and Social Norms: As primary drivers, these factors emphasize the role of social encouragement and personal aspirations.
- Self-concept: Confidence in skills such as leadership strongly boosts entrepreneurial intention.
- Academic Context: Moderate but notable, a supportive educational environment enhances entrepreneurial intention.
- Feasibility: Minimal impact suggests feasibility is not a significant perceived obstacle.

Recommendations to enhance entrepreneurial intention

Based on ANN results:

- Desirability: promote entrepreneurship through testimonials, workshops, and success stories to cultivate a positive image.
- Self-concept: offer skill-building programs focused on leadership, creativity, and innovation to boost students' confidence.
- Academic Context: incorporate experiential learning activities, such as business creation simulations and entrepreneur-led workshops, to make entrepreneurship more tangible.

DISCUSSION

Following the model adopted (table 2), it is clear that the survey results show that "Desirability and social norms" as well as "Self-concept" have a significant positive influence on entrepreneurial intention. These results are in line with the work of for whom "subjective norms and perceived behavioral control contribute significantly to the prediction of doctoral students' entrepreneurial intention".[25] Similarly for Boudabbous et al.[19] whom "only the influence of fellow students' intentions is significant" among young Tunisian graduates. Koubaa et al.[27] in their work on student entrepreneurial intention in Morocco also shows "the positive influence of entrepreneurial ability on attitude and desirability".

Regarding "Feasibility" or "perceived control" as defined by Ajzen (1991), our study has shown that it does not influence intention. Dubard Barbosa et al.[28] explain this result in their work on the perception of risk in business creation decisions by stating that "People who see business creation as a desirable behavior also consider it to be a feasible behavior. The opposite can be seen as a conceivable situation". In the same vein Boudabbous et al also assert that Financial constraints, information that can be transmitted as well as training in business creation, in other words everything that relates to perceptions of behavioral control, have a non-significant effect on intention.[19]

Our study also shows that training or raising awareness of entrepreneurship in a university context alone is not enough to encourage students to become entrepreneurs. This same conclusion is echoed by Elafqih B et al.[25] in their work with PhD students. Similarly, Boudabbous S. L[29] explains that the entrepreneurial act is still very marginal among students and that the education system does not stimulate the intention of young graduates. This leads to the argument that teaching needs to be adapted to make this career choice more "desirable". In other words, boissin et al show that teaching must also be able to make business creation and entrepreneurship an attractive, desirable career choice for students.[30]

The strong influence of social norms and desirability may reflect a form of social norms or social expectations that prompt students to declare entrepreneurial intentions, but this does not necessarily translate into a genuine willingness to act. In future research, it would be interesting to track the evolution of these intentions over time and examine whether they materialize into entrepreneurial projects.

The lack of impact of the "University Context" highlights the need to review teaching methods and incorporate more experiential approaches, such as innovation or projects with an innovative character, to improve perceived feasibility and encourage student engagement.

The ANN highlights the importance of personal perceptions (e.g., Self-concept) and social influences (e.g., Desirability). By implementing practical and structured educational strategies, institutions can further enhance students' entrepreneurial intentions.

In conclusion, while this study confirms certain key factors in entrepreneurial intentions, it also reveals gaps in current approaches, particularly in terms of perceptions of the feasibility and effectiveness of university training.

CONCLUSIONS

In conclusion, while this study confirms certain key factors in entrepreneurial intentions, it also reveals gaps in current approaches, particularly in terms of perceptions of the feasibility and effectiveness of university training.

The development of our new model for measuring entrepreneurial intention has provided in-depth insight and understanding of the key determinants influencing entrepreneurial intention among students, particularly those at ESITH. This innovative model has revealed valuable insights into the key factors that motivate engineering students to consider entrepreneurship.

The study was carried out mainly with ESITH students, which may restrict the generalizability of the results. However, this approach is voluntary, to be able to experiment with pedagogical innovations with these students

and assess their impact on both their entrepreneurial intentions and the realization of business projects.

Certain external factors, such as the influence of the economic context and institutional support for entrepreneurship, have not been examined in depth. Their inclusion could enrich the analysis of the determinants of entrepreneurial intention.

These avenues of research would enrich our current conclusions and provide a better understanding of the factors that encourage the transformation of entrepreneurial intention into concrete action.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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