International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-8, Issue-9; Sep, 2021
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.89.2

Application of factor analysis to identify entrepreneurial characteristics in students of Management and Information Technology course

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Received: 13 Jun 2021,

Received in revised form: 01 Aug 2021,

Accepted: 01 Sep 2021,

Available online: 08 Sep 2021

***Keywords*—Characteristics of entrepreneurial capacity, Entrepreneurial Training, Management and Information Technology, Factorial analysis.**

Abstract*—*The phenomenon of globalization has considerably increased the knowledge, skills and abilities in the vocational training process. Vocational training today, not only depends on the development of classroom subjects, but it also depends on training with a creative, critical focus on global solutions and a vision to improve society and the world. This is the focus of entrepreneurial qualification. This requires a multidisciplinary, systemic and comprehensive training. The objective of this article is to recognize the variables that identify the characteristics of entrepreneurship of the studied group. As for the methodology, to identify these variables, a factor analysis was used as a statistical treatment. For data collection it was used a questionnaire with 45 statements on the theme entrepreneurship, involving the issue of professional situation and intentions to open its own business. The questionnaire was answered by 235 students of Technology courses in the area of Management and Information Technology of the unit under study. The following characteristics were highlighted: self-efficacy, sociability and innovation. Other important traits for entrepreneurship development, such as planning to take calculated risks, leadership, and opportunity detection are characteristics that need to be worked on to develop these in students. The result presented can serve in the definition of strategies and structures to support pedagogical management. It can also serve as an instrument for raising awareness and supporting students in pursuing a career as an entrepreneur. It is important to constantly reflect and rethink what teaching methodologies and pedagogical approaches help to encourage learning.

I. INTRODUCTION

Organizations such as the World Economic Forum, the United Nations (UN), the Organization for Economic Co-operation and Development (OECD), and the Inter-American Development Bank study and are very interested in the characteristics and behavior of young people in relation to entrepreneurship.

Reference [28] state that, since 1985, Drucker, through their studies, identified that entrepreneurship can be taught. Later, authors [20] supported this thesis and academic organizations began working with

entrepreneurship education programs. Recent studies [44, 45, 36, 47, 48, 49, 50, 51, 52, 53, 54] show the importance of entrepreneurial education in schools and universities.

Mapping the characteristics of entrepreneurs and their actions can help to understand more about what has been achieved, as well as help to create new programs or improvements to the existing ones. Identifying the potential entrepreneur aims to make a summary of the skills, motivations and personality traits which can lead to an analysis and identification of characteristics that need to be learned and developed for the "entrepreneurial profile".

The entrepreneur needs to combine three fundamental elements: knowledge, skills and attitudes. The entrepreneur needs to combine three fundamental elements: knowledge, skills and attitudes. To combine these fundamental elements, it is important to provide comprehensive, systemic and interdisciplinary training, considering the needs of companies, with a focus on opening new companies and maintaining and growing existing companies on the market. Reconciling theory with practice [44] is of great relevance.

Activities such as preparation and evaluation of business plans and the search for financing instruments induce entrepreneurial behaviors and are part of the ability to anticipate change and take action and decision, as well as understanding the social, political, economic and cultural environment of an organization.

Another way to encourage student entrepreneurship is through activities related to technological research and development. To work [13, 14] with research is to work with doubt, it is to walk a path of investigation; is to recognize and apply the concepts of multi, inter, trans and pluridisciplinarity. And through these concepts and applications, develop the critical and scientific spirit in the student, stimulating entrepreneurship in the learning environment.

These characteristics and activities are part of the entrepreneur's daily life and need to be worked on in the academic context.

The aim of this paper is to recognize the variables that identify the characteristics of entrepreneurship of the studied group. For this it was used factor analysis.

Seeking to identify the attributes that contribute to the formation of the entrepreneurial profile, knowing that these attributes are increasingly relevant in society and that the entrepreneurial profile requires a precise definition of the characteristics which compose it.Reference [25] tested an instrument of measurement of potential entrepreneur - Carland Entrepreneurship Index (CEI) academically recognized in the US.

Authors such [18, 31, 34] highlight in their works the difficulty of working with subjective concepts which can trace characteristics for an entrepreneurial profile.

In 2005, Reference [27] built and validated an entrepreneurial attitude measurement instrument, as well as the measurement of this attitude, in owner-managers of small retail and/or service companies participating in the “Empreender” Project, in the Federal District, distributed in eleven types of sectoral centers, twelve different administrative regions of the DF, totaling 33 sectoral centers and 687 companies.

Surveying the characteristics to draw a profile which can be worked in students' vocational training, can be revealed as a potential benefit for measuring entrepreneurial intent and guidance, and may also contribute to a more efficient and effective analysis direction of potential entrepreneurs. It is important to stress here that entrepreneurial attitudes and attitudes should be encouraged.

Reference [35] emphasizes that entrepreneurial qualification is based on: learning about understanding the world, analyzing and defining the different facets of its individual and institutional context; and, creative thinking and problem solving, not forgetting competitiveness, personal mastery. It is the process in which the self-knowledge, self-development and competitiveness that is part of the business world is developed.

References [19, 30] emphasize that it is necessary to work with different educational methods, since in entrepreneurial training it is opportune to deal with the imagination, in addition to defining and structuring a space that is not yet occupied in the labor market.The importance of using various educational methods is applied to several areas of knowledge[55, 56, 67, 58, 59, 60, 61] .

This theory is related to Ausubel's cognitive learning theory and the theory of meaningful learning, which Reference [29] states needs two conditions for the process: “1) the learning material must be potentially significant and 2) the learner must present a predisposition to learn”.

The difference is in the educational process of entrepreneurial formation in which the central element is the student, with his active participation plus what he already brings from knowledge from the most diverse sources of information.

For Reference [23], the intention to undertake, the knowledge, the experience of learning by practice, the action through the exploration of the opportunities or needs (our emphasis) and the entrepreneurial behavior is the process through which education must pass the entrepreneurial education. This leads to a reflection based

on the studies by References [30, 32] state that the reference of this formation is in the process of theoretical learning, practical learning and what the author calls social learning. It is the learning from examples, both positive and negative. It considers successful entrepreneurs and entrepreneurs who have failed in business, those who persisted and who gave up.

Table 1 presents the characteristics of entrepreneurial capacity, based on the thinking of entrepreneurship schools [16].

Table.1: Characteristics of entrepreneurial capacity

Entrepreneurship School	Thought Base	Features
"Great man"	The entrepreneur has an intuitive and natural ability.	Intuition, persistence and trust,
Personal characteristics	The entrepreneur has values, attitudes and needs that differentiate him.	Need for personal fulfillment, strong personal values, etc.
Classical	The behavior of entrepreneurial approach is based on innovation.	Innovation and creativity.
Management	Entrepreneurs are those who start and run a business. Your skills can be developed.	Planning, budget and investment.
Leadership	Entrepreneurs are leaders who achieve their goals by developing their team.	Motivation, development and direction.
Intrapreneurship	Ability to develop initiatives within the company to develop them.	Identification of opportunities in the corporate environment

Important is to highlight that, the study by [1] demonstrates the Theory of Planned Behavior (TPB). The author states that personal attitudes refer to the attitude or belief towards a behavior and corresponds to the favorable or unfavorable assessment that the individual makes of that behavior, thus the characteristics presented represent the entrepreneurial profile of the studied courses and the predisposition to the entrepreneurial attitude or not.

Reference [25] state that entrepreneurship goes through social, economic and psychological variables, which ends up influencing the act of entrepreneurship. As the authors argue, this is a complex and multifaceted process through social and cultural mobility. The entrepreneur has characteristics such as: need for achievement, risk propensity, creativity, vision, high energy, strategic posture and creativity.

These characteristics are related to the entrepreneurial attitudinal characteristics presented in Table 2, used by Reference [33] to trace the entrepreneurial profile.

Table 2: Attitudinal Characteristics [33]

Attitudinal characteristics	Description
Self effective	"It is a person's cognitive estimate of his/her ability to mobilize the motivation, cognitive resources, and courses of action necessary to exercise control over events in his/her life" [36]. "In almost all definitions of entrepreneurship, there is a consensus that we are talking about a kind of behavior that includes: (1) taking initiative; (2) organize and reorganize social and economic mechanisms in order to transform resources and situations for practical gain; (3) accept risk or failure "[24].
Take calculated risks	"Individuals who need to be sure are all but impossible to be good entrepreneurs" [37]. "The corporate passport for the year 2000 will be entrepreneurial ability, that is, the ability to innovate, to take risks intelligently, to act quickly and efficiently to adapt to the continual changes in the economic environment" (Kaufman, 191, p. 3).)
Planner	"Entrepreneurs not only define situations, but also imagine visions of what they want to achieve. Their main task seems to be to imagine and define what they want to do and almost always how they will do it"[19]. "The entrepreneur is the one who

	makes things happen, anticipates the facts and has a future vision of the organization" [38].
Detect Opportunities	"It is the ability to capture, recognize, and make effective use of abstract, implicit, and ever-changing information" [39]. "That has the ability to identify, exploit and capture the value of business opportunities" [40]. "The willingness to identify opportunities is fundamental for those who want to be entrepreneurs and consists in taking every opportunity to observe business" [41].
Persistent	"Ability to work intensively, subjecting even to social deprivation, in projects of uncertain return" [42]. "Developing the entrepreneurial profile is enabling the student to create, lead and implement the process of developing new life plans... Entrepreneurial training is based on the development of self-knowledge, with emphasis on perseverance, imagination, creativity, associated innovation "[35].
Sociable	"Entrepreneurs… provide jobs, introduce innovations and stimulate economic growth. We no longer see him as uninteresting suppliers of goods and auto parts. Instead, they are seen as energizers who take necessary risks in a growing, productive economy "[43].
Groundbreaking	Reference [12] conclude that entrepreneurship is mainly a function of four elements: personality traits (need for achievement and creativity), propensity for innovation, risk and energy stance.

Innovation [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 57, 63, 64, 65] occurs when there is a successful commercial exploitation of a creation. The development of entrepreneurial attitudes has an impact on the creation or development of innovative products and services for society. The development of an entrepreneurial education can be carried out through specific disciplines of entrepreneurship and through projects and other activities that encourage innovation, the establishment of strategies, leadership and other skills, in various disciplines during a course [61, 62].

II. MATERIAL AND METHOD

For data collection, a questionnaire with 45 statements about the theme of entrepreneurship was used, involving the issue of professional situation and intentions to open his/her own business.

This questionnaire was answered by students of Technology courses in the area of Management and Information Technology of the unit under study. The answers were given by the Linkert scale (-3 to 3), from totally disagree to totally agree. The number of respondents in each class was around 40 students per accidental sample.

The applied questionnaire was divided into four categories: professional situation, obstacles, intention and motivation.

Based on the conceptual basis on the entrepreneurial profile [33], considering the various definitions found in the literature, the entrepreneurial attitudinal characteristics and developed a questionnaire were defined, with the aim to deepen and clarify the theme, without intending to exhaust it. It was also defined that the research lacked a methodological standard, which eventually imposed restrictions on the analysis of the results. Even with these difficulties, it was possible to raise characteristics and describe an entrepreneurial profile that can be worked in vocational training.

In this research, it was chosen to use this questionnaire, as it is already tested and validated. The questionnaire is entitled "entrepreneurial profile" and "entrepreneurial intention". To use other questionnaires raised in the survey, it would be necessary to test and validate each one. Due to the reduction of time, this was the one that best fit the proposal. The questionnaire underwent a minor adaptation to suit the reality of the unit, object of study.

The questionnaire aims to identify the entrepreneurial motivation of the students, with special attention to the university context, also identifying the family business past. The observation is also related to the evaluation of the university's activities and the offers related to its students 'entrepreneurial education, also evaluating the students' perceptions about the basic conditions offered by the unit for entrepreneurship.

After collecting the data, statistical analyzes were performed using the software SPSS 19 (Statistical Package for the Social Sciences).

In order to obtain the factors or constructs, from the 45 statements (variables) that were submitted to Factor Analysis (FA), which aims to identify dimensions of common variability, called factors, among a set of variables. That is, "this technique seeks to identify factors that may explain the relationship between a set of variables" [15].

According Reference [22], the objective of FA is to summarize the information contained in several original variables, in a smaller set of factors with minimal information loss.

The presented constructs came from a cross-sectional survey, ie, in a given period of time, all students answered through the online questionnaire.

Pearson's correlation coefficient (r), or product-moment correlation coefficient, which measures the degree of linear correlation between two quantitative variables was calculated. It is a dimensionless index with values between -1.0 and 1.0 inclusive, which reflects the intensity of a linear relationship between two data sets. As stated in Equation 1 below:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n(\sum x^2) - (\sum x)^2\right]\left[n(\sum y^2) - (\sum y)^2\right]}} \quad (1)$$

At where:

n = number of data pairs;

∑xy = sum of the product of the variables "x" and y ";

∑x = sum of variable "x";

∑ y = sum of variable "y";

2 x2 = sum of square of variable "x";

∑ = y2 sum of square of variable "y".

When r = 1, there is a perfect positive correlation between the two variables and r = -1 the perfect negative correlation between the two variables; that is, if one increases, the other decreases, and when r = 0, the two variables do not depend linearly on each other. However, there may be another dependency that is "nonlinear". Thus, the result r = 0 should be investigated by other means.

The correlation coefficient was used to verify which variables had no significant correlations (p> 0.05), thus such variables were removed from the analysis.

The Kaiser-Meyer-Olkin Test (KMO) [26] was performed, represented by an index that evaluates the suitability of the factor analysis, being calculated by Equation 2:

$$KMO = \frac{\sum\sum_{j \neq k} r_{jk}^2}{\sum\sum_{j \neq k} r_{jk}^2 + \sum\sum_{j \neq k} q_{jk}^2} \quad (2)$$

At where:

r2 jk is the square of the elements of the original off-diagonal correlation matrix;

q2 jk is the square of the partial correlation between the variables.

KMO index values that indicate that Factor Analysis is appropriate varies from author to author. For Reference [21] are acceptable values between 0.5 to 1.0, so below 0.5 indicates that factor analysis is unacceptable. The data from this research were appropriate for a factor analysis, so the next step was factor extraction. Then, the commonality (which is the portion of the variance that a variable shares with all other variables considered, ie, the proportion of variance explained by the common factors) of each variable, was evaluated and one by one excluded. variables with commonality lower than 0.5 in ascending order [22].

In this process, the variable with the lowest commonality was excluded and then the total variance explained and the new commonality of the other variables verified, the process continued until all the remaining variables reached commonality greater than or equal to 0.5 and thus, The cumulative variance of each model was verified (looking for the variance> 60% [22]. Finally, for each variable, the factor loadings were observed, identifying the highest load in one of the factors.

To maximize the effect of the variable on one of the factors, the orthogonal rotation method called Varimax was applied. This method emphasizes that for each major component there are only some significant weights and all others are close to zero, ie the goal is to maximize the variation between the weights of each major component. Hence the name Varimax.

Varimax rotation [17] tries to maximize the dispersion of loads within the factors, that is, it tries to aggregate fewer variables on each factor resulting in more clusters of interpretable factors.

III. RESULTS AND DISCUSSION

The total sample was 235 students. Pearson correlation coefficients between the variables were calculated. Some of them were removed from the analysis when they correlated with less than 18 variables.

The KMO test was performed comparing the best index.

1st Stage: 45-variable KMO test = 0.733 - 14 factors (Explained variance = 69.89%)

2nd Stage: KMO test with 39 variables = 0.773 - 12 factors (69.09%)

3rd Stage: 36-variable KMO test = 0.805 - 11 factors (69.31%)

4th Stage: 29-variable KMO test = 0.832 - 7 factors (66.75%)

At this moment, the explained variance of the models was verified and the largest variance was sought. For this, 7 more variables were eliminated, leaving 29 variables in the model, thus, the variables that correlated with less than 25 variables were extracted.

The analyzes were performed with and without Varimax rotation, reaching the same result. Therefore, it was decided to rotate Varimax, obtaining 7 factors and an explained variance of 66.75%.

With the results found, by using SPSS software, a comparison of the KMO test was made, eliminating some variables until it became with a high KMO index. The cumulative variance of each model was verified, looking for variance greater than 60%.

Pearson's correlation coefficients showed the variables that were most positively and negatively related. The highest positive correlation coefficient is r = 0.662 between the variables “respect for opinion” and “influence”.

Other variables that stand out in terms of correlation are “instinct” and “opportunity detection” (r = 0.642).

Some variables have negative correlation coefficients, ie the more one variable increases, the more the other decreases.

The most negative coefficient is r = -0.464 between the variables “opportunity detection” and “fear of taking risks”, that is, the more detection, the lower the fear.

The correlation coefficient between the variables “non-detection of opportunity” and “idea of entrepreneurship” is -0.357; that is, to open the business, the student visualizes the importance of opportunity detection.

The best matrix with the factor loadings was searched through the Varimax rotation, that is, when the factor loadings above 0.40 occurred in both components, the variable was removed.

Seven factors were found - 66.75% of cumulative variance and for each variable were observed the factor loadings, identifying the highest load in one of the factors.

The variables were grouped by factor and thus, it was possible to identify the characteristic of that group of variables. Such features are shown in Table 3.

Table 3: Factors found in the search

Factor 1	Entrepreneurship lacks maturity
Factor 2	Indecision and lack of proactivity
Factor 3	Innovation
Factor 4	Intuition
Factor 5	Accommodation, lack creativity
Factor 6	Ability to establish self-effective relationship network
Factor 7	Perspective

It is verified that the variables “instinct” and “opportunity detection”, as they are positively correlated, show us that the student still uses his instinct to detect opportunities, which should be further worked, while the student should use his technical knowledge to detect opportunities..

Some characteristics should be highlighted, such as persistence and idea of entrepreneurship, which are positively correlated (r = 0.570) and show that students have a perspective, being the construct or factor 7.

A striking construct found was the lack of maturity for entrepreneurship (Factor 1), a feature that should be taken into account in the preparation of the teaching and lesson plan, as Reference [30] state that it is important to learn from social learning. That is, having the successful entrepreneurs and the failing entrepreneurs as a model. Because from the cases presented, it is possible to identify how they acted during the development and growth of the business. Showing the strategies and difficulties faced during the process.

The variables that were grouped in Factor 3 showed that these students have innovation as a differential for the market, thus, according to the authors [12], who group four elements: personality traits (need achievement and creativity), propensity for innovation, risk and energetic posture for propensity to entrepreneurship.

Although the characteristic of calculated risk and creativity (Factor 5) was not found, the profile of innovative students can be verified. It is clear from these

results that while they realize how important innovation is to the market, creativity is still lacking to put this product or service into circulation.

Another factor found was intuition (Factor 4), which is not in the picture as attitudinal characteristics at the present time, but intuition was once synonymous with entrepreneurship when the entrepreneurship school saw it as a "Great Man", because this is a natural characteristic of the entrepreneur.

Reference [24] state that there is a consensus on a kind of behavior that includes: (1) taking initiative; (2) organize and reorganize social and economic mechanisms in order to transform resources and situations for practical gain; (3) accept the risk or failure ". A construct found was this characteristic self-efficacy and trust in their social network, which agrees with the profile of these authors, as these students reorganize their social mechanisms to achieve their goal, as shown in Factor 6.

Factors 2 and 7 show students have an objective, but they are afraid ofinvesting and for this reason, they retreat in the action of undertaking. Situation presented by the economic uncertainty that presents the country.

The result presented can serve in the definition of strategies and structures to support pedagogical management, as well as the definition of policies for unit management. It can also serve as an instrument for raising awareness and supporting students in pursuing a career as an entrepreneur.

As it is a cross-sectional study, it is possible to change the student's opinion due to their training and / or experiences about entrepreneurship after a while of applying the questionnaire. This limitation does not invalidate the analysis that remains relevant and significant.

It is necessary to outline and identify the real objectives that entrepreneurship education must fulfill, such as developing basic skills, creativity and innovation, helping students develop ideas and plan their own businesses; introducing them in the world of scientific research, in the production of knowledge on entrepreneurship and innovation through studies and research that contribute to the understanding of the concept, diagnosis, education and stimulation of the area should be the objective of entrepreneurial qualification. And so, leaving students without such an education and with exchanging experiences can lead to a high failure rate.

IV. CONCLUSION

Considering that the studied undergraduate courses aim to train professionals who contribute to the generation of innovation in products/services and in the processes of companies and that these professionals are able to anticipate problems and solve them, minimize costs and maximize benefits of the economic activity of the business , and all this with an ethical and sustainable perspective from the business point of view, it can be considered that this research met the need to understand the student's profile.

From the characteristics mentioned for an entrepreneur, some were highlighted in this research, such as self-efficacy, sociability and innovation. Other important traits for entrepreneurship development, such as planning to take calculated risks, leadership, and opportunity detection are characteristics that need to be worked on to develop these in students.

The construct presented was through a cross-sectional research, characterized by data collection in a single temporal moment, not allowing generalization of the results. This suggests further research of a longitudinal or even cross-sectional nature with students who already have their own business.

Although the instrument has offered a result that fits the studied theoretical framework, a new study is suggested, ie, the second round of the same material in another period, thus expanding its application and reliability.

It is proposed to analyze the entrepreneurial intention beyond the profile through other materials also tested and validated, so that different comparisons can be made.

It is important to constantly reflect and rethink which teaching methodologies and pedagogical approaches help to encourage learning and the achievement of entrepreneurial training activities.

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