

Industrial Economics in Algeria: Startups as a Mechanism for Economic Diversification and the Role of FabLab Use in Fostering Students' Entrepreneurial Intentions

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Abstract:

The Algerian economy is increasingly seeking to diversify its sources of income and reduce its dependence on the hydrocarbon sector by promoting innovation and supporting the creation of startups. In this context, this study aims to examine the role of FabLab use in fostering students' entrepreneurial intentions, drawing on Ajzen's (1991) Theory of Planned Behavior. To achieve this objective, a questionnaire was used as the primary data collection instrument and administered to students who use the FabLab at the Higher School of Applied Sciences of Tlemcen. Following data collection, 81 valid questionnaires were analyzed using the Statistical Package for the Social Sciences (SPSS Version 22). The findings revealed a statistically significant positive effect of FabLab use on students' entrepreneurial intentions. The results further indicate that the FabLab provides a conducive environment for supporting startup projects and fostering students' entrepreneurial skills. These findings highlight the potential role of FabLabs as innovation-oriented spaces that can contribute to developing entrepreneurial capacities among university students and supporting economic diversification in Algeria.

Keywords: Innovation; Startups; FabLab; Entrepreneurial Intention; Theory of Planned Behavior; Economic Diversification.

Jel Classification Codes: M13, L26, L29

1. Introduction

The International Monetary Fund (IMF), in its 2025 report on Algeria, indicated that the country recorded solid short-term economic growth. Nevertheless, the economy continues to face substantial fiscal and structural imbalances. Its long-term prospects depend on the successful implementation of structural reforms and the diversification of the economy beyond the oil and gas sectors (Bank, . 2025.)

Gert G. Mueller (2006) examined the hypothesis that entrepreneurship and university–industry relationships promote economic growth. He concluded that regions characterized by high levels of entrepreneurship and strong university–industry linkages achieve higher productivity, which in turn leads to greater economic growth. In particular, both start-up firms in innovation-driven industries and university research in engineering sciences contribute significantly to fostering economic growth (Adusei, (2016). , p. 202)

Previous research has underlined the importance of small firms in innovation, as they provide more flexibility and variability, thus improving their ability to build alliances and collaborate through projects (Acs&Audretsch, 1990; Birch, 1987). The role of small and young firms has been acknowledged as being a crucial actors in generating local economic dynamization and fostering the emergence of new businesses (Glaeser, Kerr, &Ponzetto, 2010; Henderson, 2003; Rosenthal & Strange, 2004)(Capdevila, I. ., 2015)

Innovation lies at the core of the economic model of startups and serves as a key driver of economic growth. According to Natalia (2024), startups stimulate the innovation economy while simultaneously facing significant risks and challenges, including intense competition, difficulties in accessing financing, and regulatory constraints. Furthermore, the literature indicates that innovation is a critical determinant of startup success. Innovative startups are more likely to attract investors, recruit talented individuals, and develop new products and services, thereby enhancing their competitiveness and long-term sustainability (Kartika, 2024)(Mokabli, 2025).

One of the main aspects of an entrepreneurial marketing mindset is an orientation towards innovation. In research conducted by Kraus, it was found that companies that adopt an entrepreneurial mindset in their marketing have a greater possibility of producing innovations that are relevant to market needs. This is because this mindset encourages entrepreneurs to continue to look for new opportunities and develop innovative solutions that suit market demands. In the context of digital startups, innovation occurs not only in the products and services offered but also in the way startups approach and interact with the market using digital technology(Pangilinan, 2025, p. 36)

Digital fabrication technology used in FabLabs and maker spaces affects users' think-ing, ideas, creation skills, and the ability to produce creative solutions in a wide variety of domains such as art, science, and engineering. Schmidt described "creative labs" as sites for social innovation that foster individual creativity and learning, leading to creation of knowledge and value . Culpepper and Gauntlet conceived maker spaces as creative settings for generating creativity and curiosity in individuals. An empirical study conducted by Saorin et al. in maker spaces concluded that digital editing tools and 3D printers helped in developing the engineering students' creative ability. In addition to the development of creative abilities, maker spaces are helpful in promoting collaboration, problem-solving, and communication in areas such as science, technology, engineering, and mathematics (STEM). Specifically, the relationship between creativity and maker spaces has been investigated in different research articles in the context of specific disciplines (Soomro, 2022)

Previous literature highlights the importance of innovation as a key driver of startup creation, with startups playing a significant role in promoting economic diversification and fostering sustainable economic growth. In this context, FabLabs have emerged as innovation-supportive environments that enable university students to develop their ideas, transform them into prototypes, and enhance their entrepreneurial capabilities. Accordingly, this article aims to address the following research question:

What is the role of using a FabLab in enhancing university students' intention to establish

startups?

2. Theoretical background

2.1 Innovation and Startups

Startups are not just technology companies but any companies in the process of being set up (Hermanson, 2011; Blank & Dorf, 2012; Perin, 2016; Kohler, 2016). This type of entrepreneurship happens more in the area of technology because the costs of creating a software company are lower than those of an industry. Eric Ries (2006) defines a startup as a human institution designed to create a new product or service under conditions of extreme uncertainty. Startups are the strongest manifestation of entrepreneurship and innovation (Giezzi, & Cavallo, 2020). They are distinguished from other business ventures by dynamic market expansion executed most of using modern technologies, such as information and communication (Barandiaran-Irastorza, Peña-Fernández, & Unceta-Satrústegui, 2020). Their rapid development is guaranteed by unique know-how and investor financial support (business angels; venture capital). Due to the exceptional originality of business ideas, high demand for capital, and intensive pace of development, startups are high-risk ventures that tend to be for visionaries and entrepreneurs with above-average levels of risk acceptance. Startups.com co-founder and CEO Wil Schroter has his own definition of what a startup company is. “A startup is the living embodiment of a founder’s dream,” Wil says. “It represents the journey from concept to reality. It is one of the few times when you can take something that is only a dream and make it a reality, not just for yourself, but for the entire world.” (Pekevski, 2025)

In line with start-ups being accepted as a heterogeneous group, investigations into the factors leading a start-up to success have been diverse exploring various individuals (Caliendo et al., 2023a, b; Roche et al., 2020), team (Hashai and Zahra, 2022), organizational (Lee, 2022), location (Minola et al., 2021) and relational (Cacciolatti et al., 2020) factors, with innovation receiving significant attention (Rosenbusch et al., 2011). Therefore, it is believed that for startups to survive and thrive they must first and foremost innovate (Cefis and Marsili, 2006). Start-up innovativeness, i.e. their “tendency to engage in and support new ideas, novelty, experimentation, and creative processes that may result in new products, services, or technological processes” (Lumpkin and Dess, 1996, p. 142) is widely regarded as a primary driver of performance, supported by empirical evidence (Aspara et al., 2010; Bach et al., 2019). For instance, innovation can impact firm survival, cost efficiencies, market position, competitive advantage, absorption capacity and venture capital attraction (Cefis and Marsili, 2019). However, withstanding a now generalized acceptance of the benefits of innovation, being innovative can introduce complexity, paradoxically harming performance outcomes. Accordingly, studies have shown mixed results regarding the direct relationship between innovation and financial performance (Foss and Saebi, 2017; Pittaway et al., 2004; Walker, 2004). (Donaldson, 2025)

2.3 FABLAB

In the beginning, the Fabrication Laboratory was devised at MIT by Professor Neil Gerhenfeld in 1998 and set up in 2001 with the help of his laboratory, the Center for Bits and

Atoms. The aim of this initiative, (which at the start was a training module called How to make (almost) anything, teaching students how to use digitally-controlled equipment), was to pool in a single site equipment to craft and machine materials, and design electronic circuits and microprocessors. The idea, therefore, was based on learning how to use digitally-controlled equipment to manufacture other machines. It was an immediate success, and to Neil Gerhenfeld's surprise, the course attracted not only engineers but also architecture students and artists (Capdevila, 2015; Bosqué et al, 2014; Menichinelli et al, 2015; Mérindol et al, 2016)(Liotard, 2017, p. 2)

A FabLab workshop is made up of a set of pooled digital machines available to the public in the aim of offering professional material to amateurs (Eychenne, 2012). For example, the workshop will have CAD and CAM software, laser cutting machines (for parts in wood, chipboard, leather, cardboard, etc.), digital milling machines (for sculpting complex objects in thick materials), digital rippers (more powerful than milling machines), 3D printers (for making complex parts from plastic and bioplastic, moulds and models), vinyl cutting machines (for cutting paper, card, vinyl, textiles, copper film for circuit boards) and sometimes even more specific equipment (plasma cutter, electronics workshops, machines to prototype circuit boards, and 3D scanners; Diwo-Allain, 2015)(Liotard, 2017, p. 7)

Digital fabrication technology used in FabLabs and makerspaces affects users' think-ing, ideas, creation skills, and the ability to produce creative solutions in a wide variety of domains such as art, science, and engineering. Schmidt described "creative labs" as sites for social innovation that foster individual creativity and learning, leading to creation of knowledge and value. Culpepper and Gauntlett conceived makerspaces as creative settings for generating creativity and curiosity in individuals. An empirical study conducted by Saorin et al. in makerspaces concluded that digital editing tools and 3D printers helped in developing the engineering students' creative ability. In addition to the development of creative abilities, makerspaces are helpful in promoting collaboration, problem-solving, and communication in areas such as science, technology, engineering, and mathematics (STEM). Specifically, the relationship between creativity and makerspaces has been investigated in different research articles in the context of specific disciplines (Soomro, 2022, p. 804)

Digital fabrication can have an impact on the way design is taught in higher education (Mostert- van der Sar et al., 2013; Page et al., 2016). This environment affects the way design activities are conducted (e.g., Blikstein, 2013), the content that is learned (e.g., Smith et al., 2015), and the types of outcomes (e.g., Soomro&Georgiev, 2020). As a result, both process and outcome are affected by this tool in design education(Georgiev, 2022, p. 3)

The digital fabrication curriculum covers standard technologies supported by FabLabs and makerspaces (Blikstein&Krannich, 2013; Hielscher& Smith, 2014). The technological dimensions analyzed in this study are partly grounded in the study by Milara and colleagues (2017), which includes 2D design, 3D design, electronics, programming, and operation of the tools and devices supporting digital fabrication. These dimensions generally map with the content and learning outcomes of a standard digital fabrication curriculum (Iwata et al., 2020; Mostert-van der Sar et al., 2013) (Georgiev, 2022, p. 4)

2.4 The Intention to Establish and Institution.

The Theory of Planned Behavior is a reference for the majority of research that focused on the study of intended behaviour. The Theory of Planned Behavior considers the intention almost as an absolute predictor of behaviour; it explains and predicts how the cultural and the social environment affect the behaviour of the individual. The theory is based on the intention of the individual as a result of three factors (attitude towards behaviour, subjective norm, perceived behavioural control) (Mouloungui, 2012).

The term "intention" refers to the mind process that suggests a purpose, tools or intentional objects (Bloy, 2003; Lalande, 1993), for Kélévitch (1983), the intention is consciousness attracted by the very near act, and it is a stimulus towards future action that is about to occur. It is a will to build, and it is also a vague and unstable probability, and at the same time, there is no certainty of its achievement (Moreau, 2006, p. 105).

Kolvereid's (1996) conception of the intention stems from Ajzen and Fishbein's concept which they both call the intention of choice. The intention then is the reference of choice between following the entrepreneurial path and an employee's path (Boissin, 2009, p. 30). It is believed that a person's purpose to be an entrepreneur is a good judge of his / her truly engagement in the field of entrepreneurship in the future (Delmer & Davidson 2000, Kruger, Reilly and Carsrud, 2000), instead of the characteristics and demographic methods. Therefore, studies in the sphere of entrepreneurship rely on intention models, as entrepreneurial performance is in fact planned behaviour (Krueger et al. 2000). Fishbein and Ajzen (1975) operationalised intention as the possibility to proceed. Two intention models appear as vital in this research and they are Ajzen's (1987) Theory of Planned Behavior (TPB) and Social Cognitive Theory (SCT), initially referred to as Social Learning Theory (Bandura, 1977) (Akinbola, 2020, p. 2300).

3. Methodology

3.1. Objective and hypothesis

Based on the study model represented by Ajzen (1991), the following hypotheses are formulated as follows:

H1: The use of the FabLab laboratory has a positive effect on the intention to establish a startup.

3.2. Participants

The study targeted a sample of second-cycle students at the Higher School of Applied Sciences of Tlemcen, Algeria, who use the FabLab laboratory. A total of 81 questionnaires were collected during the second semester of the 2025/2026 academic year, and all of them were valid for statistical analysis.

3.3. Instrument

To examine the relationship between the study variables in accordance with the proposed research model, a questionnaire was used as the data collection instrument. The questionnaire was divided into three sections. The first section collected the respondents' demographic information, while the second section consisted of items measuring the use of the FabLab laboratory. The third section included items measuring the intention to establish a startup.

A five-point Likert scale was used to measure the respondents' level of agreement with the questionnaire items..

4. Results and data analysis

4.1.Exploratory factor analysis and reliability

The validity and reliability of the questionnaire are tested with several instruments, the most famous of which is Cronbach's Alpha, based on the calculation of the internal correlation between the answers of the questions. It takes a value between 0 and 1. According to many researchers, Cronbach's Alpha, in enterprise intention research, is limited to 0.49 and 0.94 (Tounés, 2003).

It can be concluded from Table (3) that the reliability coefficient of the study variables exceeds the value of 0.60. The Cronbach's Alpha coefficients for both the use of the FabLablaboratory and the intention to establish a startup are higher than 0.64, indicating that the questionnaire has an acceptable level of reliability and internal consistency.

Furthermore, the validity coefficient, calculated by taking the square root of the reliability coefficient, exceeds 0.80 for all study variables. This indicates that the questionnaire has a high level of validity and effectively measures what it was designed to measure. Therefore, it is considered suitable for representing the study population from which the sample was drawn.

Table . 1: Chronbach's alpha

Variable	Coefficients Chronbach's alpha	Coefficients Validity	Number of items
FabLabLaboratory Usage	0.814	0.902	12
Intention to create a startup	0.645	0.919	02

4.2 The use of principal component analysis

Kaiser-Meyer-Olkin's indicator signals the adequacy of the sample elements for the study and most references in this regard state that its value is greater than or equal to 0.5. The significance of the Barttelet's test is that the null hypothesis is rejected and the alternative hypothesis is accepted, that is, there are no correlation coefficients. The significance of this test should be less than 0.05 (Dauriat, 2011).

These indicators are sufficient to be used in the analysis in major compounds, which aims to reduce a group of variables and group them into axes. This will not happen unless there is a link between them. The Principal Component analysis (PCA) is a way to reduce the data that is chosen from among the primary variables items, and the most involved in describing the phenomenon studied at this level (Tounés, 2003).

It is evident from Table (02) that the Kaiser-Meyer-Olkin (KMO) index for the study variables is greater than 0.50, indicating the adequacy of the sample for conducting the study and factor analysis. We also note that the value of Bartlett's Test of Sphericity is less than

0.05 for the study variables, which indicates the existence of statistically significant correlations among the items of the variables under investigation. Therefore, the use of factor analysis based on the Principal Component Analysis (PCA) method is justified.

Table . 2: Indicator KMO and significance of the Barttelet test

Variable	KMO	Barttelet	Number of items
FabLabLaboratory Usage	0.690	0.00	12
Intention to create a startup	0.610	0.00	02

Table (03) presents the extracted factors for each study variable along with their corresponding Eigenvalues. Only factors with an Eigenvalue greater than 1 were retained according to the Kaiser criterion. The table also shows the percentage of the total variance explained by the extracted factors.

Regarding the independent variable, FabLab Usage, four factors were extracted, explaining 54.966% of the total variance. This indicates that the measurement items adequately represent the underlying dimensions of the construct.

As for the dependent variable, Intention to Create a Startup, one factor was extracted, explaining 86.821% of the total variance. This result indicates that the items measuring this construct are highly homogeneous and represent a single underlying dimension, confirming the construct validity of the scale.

Table .3: Total variance explained

Variable	Number of factors	Total variance explained
FabLabLaboratory Usage	4	54,966
Intention to create a startup	1	86,821

4.3.Simple linear regression

Simple linear regression is one of the advanced statistical methods that ensure the accuracy of inference in order to improve research results through optimal use of data in finding causal relationships between the phenomena in question. It works on finding a mathematical equation that expresses the relationship between two variables and is used to estimate previous values to predict future values. It is used to predict changes in the dependent variable in terms of the influence of the independent variable.

4.4.The descriptive analysis of the study variables

The results presented in Table (04) indicate that FabLab Usage ranked first, with a mean score of 52.8628 and a standard deviation of 8.50809, reflecting a high level of FabLab usage among the respondents.

Regarding the dependent variable, Intention to Create a Startup, the mean score was 5.6389,

with a standard deviation of 1.75312, indicating the respondents' level of intention to establish a startup.

Table .4: Descriptive Analysis of the Study Variables

Codage	Moyenne	Ecart type
INT	5,6389	1,75312
FU	52,8628	8,50809

4.5.The regressionmethod

Table (05)presents the regression method used in the analysis based on the SPSS Version 22 output. The results indicate that the Entermethod was employed, whereby the independent variable, FabLab Usage, was entered into the simple linear regression model without any variables being excluded. Consequently, the analysis proceeded to examine the relationship between the independent variable, FabLab Usage, and the dependent variable, Intention to Create a Startup.

Table .5: Regression Method

Modèle	Variables Introduites	Variables Supprimées	Méthode
1	FabLabLaboratory Usage	/	Entrée

4.6.The significance of the regression

Table (06) shows that the correlation coefficient (R) between the independent variable, FabLab Usage, and the dependent variable, Intention to Create a Startup, is 0.548, indicating a positive relationship between the two variables.

The coefficient of determination (R^2) is 0.276, indicating that 27.6% of the variance in Intention to Create a Startupis explained by FabLab Usage, while the remaining 72.4% is attributed to other factors not included in the research model. The adjusted coefficient of determination (Adjusted R^2) is 0.270, confirming the explanatory power of the regression model.

Furthermore, the Standard Error of the Estimate is 1,59720, which is relatively low, indicating that the proposed regression model provides a good fit to the data with a low level of estimation error.

Having established the existence of a relationship between FabLab Usage and Intention to **Create a Startup**, the next step is to examine the statistical significance of the regression model in order to assess the effect of **FabLab Usage** on **Intention to Create a Startup**.

Table . 6:Model Summary

Modèle	R	R-deux	R-deux ajusté	Erreur
1	,548 ^a	,276	,270	1,59720

4.7.Analysis of variance (anova)

To test the significance of the regression model, an Analysis of Variance (ANOVA) was

performed. As shown in Table (07), the calculated F value (70.622) is greater than the critical F value (2.60). In addition, the significance level (Sig = 0.000) is less than 0.05, indicating that the regression model is statistically significant.

Therefore, it can be concluded that there is a statistically significant relationship between the independent variable, FabLab Usage, and the dependent variable, Intention to Create aStartup, at the 5% significance level ($\alpha = 0.05$). These results confirm that FabLab Usage has a significant effect on Intention to Create a Startup.

Table .7: Analysis of Variance (Anova)

Modèle	Somme des carrés	Ddl	Moyenne des carrés	F	Sig
Régression	523,407	3	181,135	70,622	0.00
1 Résidu	1235,071	452	2,255		
Total	1887,520	753			

3.8. The testing of the study hypothese

H1: FabLab Usage has a statistically significant positive effect on Intention to Create a Startup. Table (08) presents the regression coefficients. The standardized regression coefficient (Beta) is 0.451, indicating the strength and direction of the relationship between FabLab Usage and Intention to Create a Startup.

The results also reveal a statistically significant effect of the independent variable (FabLab Usage) on the dependent variable (Intention to Create a Startup) at the 5% significance level ($\alpha = 0.05$). The calculated *t* value is 9.521, while the significance level (Sig. = 0.000) is less than 0.05, indicating that the regression coefficient is statistically significant.

Therefore, it can be concluded that FabLab Usage has a positive and statistically significant effect on Intention to Create a Startup, supporting the proposed research hypothesis.

Table .08:coefficients

Modèle	Coefficients standarisés		Coefficients standarisés	A	Sig
	B	Ecart standard	Bêta		
1(constante)	0.385	0.377	0.451	1.016	,310
FabLabLabo ratory Usage	0.100	0.007		9.521	,000

4. Discussions

The findings confirmed the study hypothesis, which posited a positive effect of FabLab use on students' entrepreneurial intentions. The independent variable, namely FabLab use, was able to explain part of the variance in students' intentions to establish startups.

The results further showed that 80% of the participating students reported that the FabLab helps them transform their ideas into prototypes. They also indicated that the FabLab enables them to acquire technical skills and contributes to strengthening their innovation capabilities. More than 70% of the students considered that the FabLab provides a positive environment for teamwork and helps reduce the costs associated with testing their entrepreneurial projects. Moreover, access to the equipment and machinery available at the FabLab enhances their self-confidence in developing and implementing their projects.

Responses related to students' entrepreneurial intentions revealed that 80% of the students who regularly use the FabLab expressed an intention to establish a startup after graduating from university.

5. Conclusions

This study sought to examine the creation of startups from a behavioral perspective by analyzing students' intentions to establish startups within the university environment, based on the premise that business creation constitutes a planned behavior. From a theoretical perspective, the Theory of Planned Behavior (TPB) was adopted as it is one of the most widely used models in studies addressing entrepreneurial intentions among university students. The study specifically examined the role of students' use of the FabLab, a digital fabrication laboratory that contributes significantly to accelerating idea generation and fostering innovation.

The results of the regression analysis showed that the statistical model was statistically significant, confirming the existence of a statistically significant relationship between the independent variable, FabLab use, and students' intentions to establish startups. These findings highlight the importance of expanding student access to and use of FabLabs in order to direct resources toward sustainability and innovation and to promote the emergence and development of startups in strategic sectors. Startups can serve as a key instrument for economic diversification by paving the way for new, technology-intensive sectors that are less dependent on traditional activities. In this regard, Jean-Michel Sohut (2019) points out that high-growth startups can play a particularly important role in the structural transformation of economies by redirecting resources toward emerging and innovative fields.

The study also highlighted the importance of establishing laboratories and fabrication spaces, such as FabLabs, within university settings, particularly in technical disciplines. These spaces have the potential to bring about fundamental changes in production patterns through the capabilities of digital equipment and the resources they provide. Students can benefit from digital technologies that help reduce costs, design solutions to problems, and implement them. Accordingly, digital fabrication laboratories (FabLabs) provide an environment that enables students to engage in unprecedented, hands-on and in-depth design experiences, involving multiple cycles of design and redesign. They also allow students to experience new levels of both frustration and enthusiasm—emotions and experiences that they do not typically encounter within their conventional educational experiences.

This study was limited to examining students' intentions to establish startups, which opens the way for future research to investigate the role of support and mentoring institutions, as well as

financial support organizations, in helping students transform their innovative ideas into actual projects and establish startups in Algeria. Such efforts are particularly important in the context of economic diversification and the development of a more innovation- and technology-driven economy.

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