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	<p>RESEARCH ARTICLE </p>
	<h2>University Business Incubators and Their Role in Promoting Technological Innovation in Start-ups: An Exploratory Study of University Students</h2>
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Keywords	<p>University business incubators; Technological innovation; Start-ups; Entrepreneurship; Innovation ecosystems.</p>
Abstract	<p>University business incubators have emerged as strategic mechanisms for fostering entrepreneurship and accelerating technological innovation, particularly among student-led start-ups. This study aims to examine the role of university business incubators in promoting technological innovation as a core component of start-up strategies. The research adopts a descriptive-analytical approach, combining a conceptual review of university business incubators and technological innovation with an empirical investigation. Data were collected through a structured questionnaire administered to a sample of 46 students affiliated with the Business Incubator of Tissemsilt University. The Statistical Package for the Social Sciences (SPSS) was employed to analyse the data and test the study hypotheses. The results reveal a statistically significant impact of university business incubators on promoting technological innovation in start-ups at a significance level of 0.05. Moreover, the findings indicate a positive correlation coefficient of 39.7%, reflecting a moderate relationship between incubator support and technological innovation. The study concludes that university business incubators play a crucial role in enhancing students' innovative capabilities by providing a supportive entrepreneurial ecosystem. Accordingly, the research recommends strengthening technological infrastructure within incubators, including access to advanced technological equipment, specialised software, high-speed internet, coworking spaces, and continuous technical support. Furthermore, the establishment of strategic partnerships with technology firms and the organisation of training programmes and workshops led by experts in technology and entrepreneurship are essential for maximising the innovative potential of start-ups.</p>

✓ JEL Classification Codes: L26; M13; O32.

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1. Introduction

In a world where technological development is accelerating at a rapid pace, stimulating and promoting technological innovation is crucial. Although technology is a key factor in achieving competitive edge and sustainability in the market, it poses significant challenges for start-ups, making it difficult for them to grow and succeed.

Business incubators are vital in promoting technological innovation and supporting start-ups in achieving sustainable growth. Business incubators provide a suitable and supportive environment for start-ups to develop and experiment with new ideas and technologies, it also provides financial support to it, and this helps accelerate research and development of new technology. In addition to enhancing communication and cooperation between start-ups and other companies and experts in the field of technology. This networking provides an opportunity to exchange knowledge and ideas and develop strategic partnerships, enhancing the ability of start-ups to develop innovative technological solutions and increase their impact in the market.

Business incubators provide administrative and advisory support to start-ups, including guiding companies in growth strategies, process optimization, and risk management. This support helps build the company's capabilities and increase its chances of success in the competing technology market.

Do university business incubators (which are considered start-ups incubators) have a role in fostering a thriving knowledge economy? Through an in-depth study of start-ups incubators, we will explore their role by nurturing entrepreneurial talent, encouraging innovation, and stimulating knowledge-based industries. Start-up incubators play a vital role in fostering a vibrant entrepreneurial environment, empowering local talent, and driving economic diversification (Abdelghani & Amara, 2024).

Start-ups have great potential for economic development, as they can contribute to job creation, innovation, and economic diversification. Therefore, it is necessary to create a more conducive environment for start-ups development, including activating the role of university business incubators, which are considered the scientific and practical support and facilitators for start-ups (Necib, 2024).

University business incubators are of paramount importance in supporting and supporting start-ups. This comes in light of the growing interest in these companies, which are relied upon as the foundation of the economic model aimed at achieving economic development. University business incubators play a pivotal role in supporting and supporting the establishment of start-ups by university students and researchers, and in obtaining innovative project labels and patents (El Cheikh, Meziane, & Benantar, 2023).

University business incubators are one of the mechanisms supporting start-ups. They serve as a mechanism for encouraging creative initiatives by university students in the form of start-ups companies, as summarized by some university business incubator models (Ben Saâda & gourari, 2023).

University business incubators are part of a university ecosystem, which plays an role in the journey of start-ups from the lab to the market. (Madi & Madi, 2024).

University business incubators play a role in promoting the growth and sustainability of start-ups in various economies, contributing to improving and enhancing their effectiveness in fostering innovation and economic and social growth in various economic contexts (Touati, Saad, & Abdelkrim, 2024).

Innovation management plays an important role in high-tech start-ups, and innovation management is closely and positively related to competitive advantage in high-tech start-ups (Adjali & Benmensour, 2018).

University business incubators are a suitable and supportive environment for developing technological innovation for start-ups. This is embodied in university scientific laboratories that seek continuous research and development in the technological aspects of start-ups.

This study derives its importance from the need to highlight the role of business incubators in promoting technological innovation, a fundamental element of start-ups strategies. This role is ensured by providing technological infrastructure within the incubator, allowing entrepreneurs to access the latest technological tools and technologies to develop their projects.

Our study is distinguished by its added value from previous studies by providing different and complementary aspects at the same time, in the theoretical aspect we sought to integrate with previous studies and enhance them with new information about the University business incubators and their role in promoting technological innovation in start-

ups, while in the second part, our study was distinguished from other studies as it highlighted the problem of The role of business incubators at Tissemsilt University in promoting technological innovation in start-ups.

This study seeks to achieve a number of objectives, including: Evaluate the programs and services provided by the business incubator at the University of Tissemsilt to promote and stimulate technological innovation; Define the concept of business incubators, their dimensions and the services they provide; Identify the importance of innovation in the success of start-ups; Identify the relationship between business incubators and technological innovation.

We relied in our study on the descriptive and analytical approach, by describing and Presentation of business incubators, their different roles and dimensions, and description and definition of technological innovation and its importance for the success of start-ups. We used the analytical approach to analyze the questionnaire results, so that a questionnaire was distributed to a sample of 46 students at the University of Tissemsilt Business Incubator, and the statistical packages program used in the social sciences SPSS was relied on to analyze Results and hypothesis testing. Accordingly, we pose **the following main question**: What is the impact of business incubators in promoting technological innovation as an essential part of start-ups strategies?

To answer this question, we pose **the following sub-questions**:

- Is there a statistically significant relationship of technical and technical support with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator?
- Is there a statistically significant relationship of finance and capital management with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator?
- Is there a statistically significant relationship of networks and relationships with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator?
- Is there a statistically significant relationship of effective infrastructure and resources with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator?
- Is there a statistically significant relationship for personal training and development with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator?
- Is there an impact of the dimensions of business incubators on promoting technological innovation as an essential part of start-ups strategies?

We will try to answer **the following hypotheses**:

Main hypothesis: There is an impact of business incubators in promoting technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator at a morale level of 0.05%.

Sub-hypotheses:

- There is a statistically significant relationship between technical and technical support and the promotion of technological innovation as an essential part of the start-ups strategies of the Tissemsilt University Business Incubator at a significant level of 0.05%.
- There is a statistically significant relationship between finance and capital management while promoting technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator at a moral level of 0.05%.
- There is a statistically significant relationship between the networks and relationships with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator at a significant level of 0.05%.
- There is a statistically significant relationship between infrastructure and effective resources with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator at a significant level of 0.05%.
- There is a statistically significant relationship between training and personal development with the promotion of technological innovation as an essential part of the start-ups strategies of the University of Tissemsilt Business Incubator at a moral level of 0.05%.

The scientific article is divided into two sections, theoretical and applied. These are preceded by an introduction and followed by a conclusion that includes the research findings and a set of recommendations, as follows: First section is devoted to the theoretical literature on business incubators and technological innovation; Second section is devoted to the field study (preparing the questionnaire, distributing it, processing its outputs, and extracting and analyzing the results).

2. Literature Review

During this theme, we will address the literature related to the variables of the study.

A. University Business Incubators:

University Business Incubators are a powerful tool to promote entrepreneurship and develop the local economy. These incubators provide a favorable and supportive environment for startups, helping them overcome challenges and succeed in a competitive business market.

a. The concept of University Business Incubators:

A business incubator is defined as a stand-alone institution and may be a government institution or a private or mixed institution, which is an institution to encourage, develop and support start-ups, providing them with a range of services, facilities and opportunities to connect communication networks in order to help them overcome the obstacles of starting (Al-Ghoul & Al-Ahmar, 2021, pp. 323-324).

University business incubators are programs or centers that support entrepreneurs and innovators at universities. These incubators provide a conducive environment for developing business ideas and projects by offering a range of services, such as guidance and counseling, physical space, training, funding, and networking. University business incubators seek to foster a spirit of innovation and entrepreneurship among students, contributing to the development of the local economy and enhancing employment opportunities.

b. Objectives of the University Business Incubators and the services it provides:

There are many goals of business incubators, but they are aimed at a main goal, which is to offer many successful entrepreneurs and institutions that continue in the market in order to achieve economic support and sustainable development, and the objectives can be limited as follows:

- Providing financial and advisory services for the establishment of projects in addition to facilities to help enterprises overcome administrative, financial and other obstacles that may be faced at the establishment stage;
- Evaluation of incubated projects to identify weaknesses and address them for continuous improvement;
- Launching social projects with the aim of solving social problems;
- Supporting university and institute graduates to establish their own projects and transform their ideas and research into practical applications on the ground ;
- Training students and developing their management and leadership skills ;
- Conversion of laboratory research into goods and services;
- Assist in the transfer of high technology from developed countries in order to promote its application in the local community to serve the national economy ;
- Contribute to the development of human resources, provide jobs, increase the per capita income rate, increase the number of projects... etc;
- Providing a suitable climate and atmosphere for the establishment of service and production projects to serve the community.

As for the services provided by incubators for incubated projects, they are represented in (BENKHEDIDJA, 2017, pp. 214-215):

- **Strategic services:** securing intellectual property, preparing marketing and financing strategies, providing display screens, implementing business plans, consulting teams.
- **Procedural services:** It includes all the necessary procedures for startups such as providing marketing resources, funding, human resources and communication networks, in addition to the initial procedures that enable them to launch successfully.
- **Infrastructure:** Provision of suitable spaces with furniture, telephone, internet, fax, meeting rooms and other matters.

c. Dimensions of University Business Incubators:

They include the main dimensions of (KHEMKHAM, 2022, p. 15):

- **Technical and technical support:** by providing all services and techniques such as preparing plans, economic feasibility studies, preparing advanced designs for new products, and providing the necessary technological means.
- **Financing and capital management:** Incubators provide multiple mechanisms for financing through government programs, financing companies, or linking incubated institutions with investors to adopt the project after the incubation period, and the incubator also provides all financial and accounting studies for the incubated institution such as work plan and economic feasibility studies... etc (MERZOUG, 2023, pp. 744-748).
- **Networks and relationships:** The incubator aims to enhance cooperation and coordination between various research, university and economic institutions, and also works to link businessmen with owners of emerging institutions.
- **Efficient infrastructure and resources:** Incubators provide business spaces with all the basic resources, supplies and services necessary to help emerging institutions such as offices, equipment, meeting rooms... Etc.
- **Personal training and development:** The incubator provides all assistance from training, education, consulting and assistance in product development and marketing, i.e. it fills all the gaps in individuals through initial training on business administration.

B. Technological innovation:

Technological innovation is the process of developing and applying new ideas and technologies to improve processes, products and services in technology. It aims to achieve progress and development in various fields such as communications, computing, energy, robotics, artificial intelligence, and e-commerce.

Technological innovations are an essential part of the process of economic and social development. They help improve productivity, reduce costs, and enhance the competitiveness of companies and countries. Thanks to

technological innovation, processes improve and products and services evolve, improving the quality of life and better meeting the needs of consumers.

a. Definition of technological innovation:

Technological innovation represents the process of developing or using technology in an innovative or new way to improve an existing process or solve a specific problem, and its meaning indicates the power of vigilance and acumen that distinguishes the organization from other organizations, which makes it fully aware of all the variables and events that surround it, and everything that revolves around the world of technology in particular, which has to do with the type of organization's activity in order to benefit from it and employ it in production methods and in the services provided (YOUNES, 2022, p. 553).

b. The importance of innovation in the success of start-ups:

Startups find themselves facing many shocks that threaten their survival and continuity in the market, which makes the adoption of creativity and innovation imperative for them to adapt to these changes and developments to improve their performance and for competitive excellence, as the importance of innovation is represented in (KHADICH & MERABTI, 2022, pp. 88-89):

– **Competitive advantage:** Competitive advantage is the main pillar of startups and their development, which achieves leadership and control in the market in which they operate.

– **Increase efficiency and productivity:** by constantly innovating new solutions to problems or improving existing solutions, so that facing challenges and solving problems becomes easier, this ultimately leads to achieving work efficiently and more productively.

– **Competition with large companies:** The innovative process is of great importance in enhancing the success of startups and increasing their competitiveness, as soon as there is a new innovative idea in the market, it represents a source of development for large companies and creates a turbulent atmosphere in the work environment, and therefore the success of startups depends on the culture of the organization and its encouragement of knowledge production and innovation based mainly on the quality of the human element.

3. Research Methodology

The descriptive approach was relied on in the theoretical aspect by presenting the literature related to the study variables, by describing and Presentation of business incubators, their different roles and dimensions, and description and definition of technological innovation and its importance for the success of start-ups, while the applied side was based on the analyze approach that focuses on numbers and statistics (quantitative side), using the case study method by distributing a questionnaire to a sample of a student at the University of Tissemsilt Business Incubator, then testing and studying the results by the statistical packages program used in the social sciences SPSS was relied on to analyze Results and hypothesis testing.

Population and sample of the study:

In order to complete the field study, a questionnaire form was distributed to a sample of (46), 42 questionnaires were retrieved, i.e. 91.3%, and 36 study able questionnaires were accepted, i.e. 85.7% of the retrieved.

Alpha Cronbach test:

Table 1. Alpha Cronbach Test

Dimension	alpha Cronbach Laboratories	Observation	Number of ferries
Technical and technical support	0.900	High stability level	04
Networks & Relationships	0.818	constant	04
Finance & Capital Management	0.865	constant	04
Efficient infrastructure and resources	0.831	constant	04
Personal Training & Development	0.746	constant	04
The first axis is business incubators	0.888	constant	20
Second erasure technological innovation	0.882	constant	06

Source: Prepared by the researcher based on the outputs of SPSS

We verified the stability of the study through the alpha Cronbach coefficient and the result was as shown in the previous table where the levels of the VA alpha Cronbach coefficient for all dimensions were very high, which means that the stability is high and statistically significant. Thus, the results of the questionnaire can be generalized to the entire sample population.

Normal distribution test:

Table 2. Normal Distribution Test Results

Domain	Test Value	Probability Value (sig)
X	0.200	0.065
Y	0.65	0.107

Source: Prepared by the researcher based on the outputs of SPSS

From the results shown in the table above, it is clear that the p-value of most of the study axes is greater than the significance level of 0.05, and thus the distribution of data for these axes follows the normal distribution, which

confirms the possibility of applying the model plan, where parameter tests were used to analyze the data and test hypotheses.

Order of importance of study variables:

Table 3. Ranking of the importance of the study variables

Ingredients	Average	Standard deviation	Importance level	Level	Order
Technical and technical support	3.60	0.583	72%	High	1
Networks & Relationships	3.40	0.707	68%	medium	4
Finance & Capital Management	3.06	1	61.12%	medium	5
Efficient infrastructure and resources	3.45	0.948	69%	medium	2
Personal Training & Development	3.43	0.671	68.6%	medium	3
Business Incubators	4.10	0.720	82%	High	

Source: Prepared by the researcher based on the outputs of SPSS

Pearson Correlation Matrix for Business Incubator Dimensions on Technological Innovation:

Table 4. Pearson Correlations Matrix for Business Incubator Dimensions on Technological Innovation

Ingredients	Correlation coefficient	Significance constant value	Number of people Sample (N)
Technical and technical support	0.426 [*]	0.010	36
Networks & Relationships	0.305 [*]	0.070	36
Finance & Capital Management	0.430 [*]	0.009	36
Efficient infrastructure and resources	0.335 [*]	0.046	36
Personal Training & Development	0.402 [*]	0.015	36
Nursery	0.718 [*]	0.000	36

Source: Prepared by the researcher based on the outputs of SPSS

We note through the table that there are correlations between the dimensions of business incubators and technological innovation as an essential part of the strategies of emerging institutions, where we were able to answer the hypotheses of the study (**hypotheses related to the relationship of dimensions of the independent variable and their relationship to the dependent variable**) as follows:

- **After technical and technical support:** There is a relationship between technical and technical support with technological innovation as an essential part of startup strategies.
- **Networking and Relationships Dimension:** There is no relationship between networks and relationships with technological innovation as an essential part of startup strategies.
- **Funding and capital management dimension:** There is a relationship between finance and capital with technological innovation as an essential part of startup strategies.
- **Efficient infrastructure and resources:** There is a relationship between efficient infrastructure and resources with technological innovation as an essential part of startup strategies.
- **After training and personal development:** There is a relationship between personal training and development support with technological innovation as an essential part of startup strategies.

Linear correlation coefficient between the independent variable and the dependent variable:

Table 5. Linear correlation coefficient between the independent variable and the dependent variable

model	Correlation coefficient	Coefficient determination	of Standard error
Technological innovation	0.537	0.288	0.22514

Source: Prepared by the researcher based on the outputs of SPSS

From the previous table, we note that the correlation coefficient is equal to 0.537, which means that the relationship is medium and positive, and organizational excellence explains 28.8% of technological innovation, while the miscalculation reached 0.22514, and accordingly: "There is a strong positive correlation between the dimensions of university business incubators and technological innovation as an essential part of startup strategies.

Regression line significance variation:

The table below shows the regression line analysis, which studies the suitability of the data regression line and its null hypothesis that the regression line does not fit the data provided.

- **H₀:** There is no effect of the dimensions of university business incubators on technological innovation as an essential part of the strategies of startups at a level of 0.05%
- **H₁:** The effect of the dimensions of university business incubators on technological innovation as an essential part of the strategies of startups is found at a level of 0.05 %

Main hypothesis test results (ANOVA analysis):

Table 6. Main hypothesis test results (ANOVA analysis)

Prototype	Sum of squares	Degree of freedom	Average squares	Fisher value	P-value
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Regression	2.860	1	2.860	6,350	0.017
Rest	15.315	34	0.450		
Total	18.175	35			

Source: Prepared by the researcher based on the outputs of SPSS

From the above table, we note that the value of Fisher reached 6,350 and the p-value was **sig = 0.017**, which is less than 0.05, including the hypothesis that there is a statistically significant impact of the dimensions of university business incubators on technological innovation as an essential part of emerging enterprise strategies at a significant level of 0.05%.

Simple regression line coefficients:

Table 7. Simple Regression Line Coefficients

Prototype	Standard coefficients		Standard coefficients	Test the value of T	Sig
	B	Standard error	Beta		
constant	2.404	0.685		3.510	0.001
Technological innovation	0.448	0,178	0.397	2.520	0.017

Source: Prepared by the researcher based on the outputs of SPSS

We note from the table that the probability value of the dimensions of business incubators (sig = 0.017) is less than ($\alpha < 0.05$) and this means accepting the main hypothesis, i.e. there is a clear impact of the dimensions of university business incubators on technological innovation as an essential part of the strategies of emerging institutions at a level of significance 0.05%.

Simple linear regression equation:

$$Y = 2.404 + 0.448X$$

Y = technological innovation

X = Business Incubators

The equation indicates that there is a clear impact of the dimensions of university business incubators on technological innovation as an essential part of the strategies of emerging institutions at a level of 0.05%, where the increase in the independent variable by one degree leads to an increase in the level of the dependent variable by (0.448).

4. Results and Discussion

Through all of the above, we reached the following results:

– According to the opinions of students belonging to business incubators at the University of Tissemsilt, technical and technical support represents 72% of technological innovation as an essential part of startups strategies, which indicates that it is more important, followed by the dimension of networks and relationships with an important percentage of 69%. Then after training and personal development by 68.6%, and we find in the end after financing and capital.

– Through the Pearson correlation coefficient, there is a correlation between the variables of the study, where there is a correlation between the dimension of technical and technical support and the dimension of technological innovation as an essential part of the strategies of emerging institutions, the value of the correlation coefficient was 42.6%, and this indicates a positive relationship between technical and technical support and after technological innovation as an essential part of the strategies of emerging institutions, which is statistically significant, that is, the greater the technical and technical supported technological innovation as an essential part of startup strategies, and the correlation coefficient between networks and relationships with technological innovation as an essential part of startup strategies reached 30.5%, which is not statistically significant, and there is a correlation between finance and capital and after technological innovation as an essential part of startup strategies, as its value reached 43%, meaning that the more funding increases, technological innovation increases as an essential part of startup strategies, and the correlation coefficient between infrastructure, effective resources and technological innovation as an essential part of startup strategies reached 33.5%, which indicates that there is a positive and positive relationship between infrastructure and development. Technology car as an essential part of the strategies of emerging institutions, and the correlation coefficient for the dimension of training and personal development reached 40.2%, while the variable of business incubators in all its five dimensions reached a correlation coefficient of 39.7%, and this indicates a direct correlation between the dimensions of business incubators and technological innovation as an essential part of startup strategies.

– Through the ANOVA test and the regression line coefficients sentiment test, it is clear that there is an impact of business incubators on technological innovation as an essential part of the strategies of startups at a level of 0.05 %, depending on the probability value, which was less than the level of significance 0.05%. The regression line coefficient test indicates the amount of change in the study variables, where the increase in the independent variable business incubators by one degree leads to an increase in the level of the variable of technological innovation as an essential part of the strategies of emerging enterprises by (0.448).

5. Conclusions

Business incubators are an effective link between startups with entrepreneurs and investors, and provide vital care by providing an appropriate environment to enhance research and development processes to accelerate the achievement of the set goals, which enhances their growth and continuity opportunities. In light of these rapid technological transformations and developments in our world, we realize the importance of business incubators as a driver and supporter to promote technological innovation and develop startups.

Recommendations:

To enhance and improve the work of university business incubators to foster technological innovation within startups, we recommend the following:

- Providing a technological infrastructure within the incubator to enable entrepreneurs to access technological devices and the latest technologies to develop their projects.
- Forming partnerships between business incubators with technology companies.
- Providing financial support for promising technological projects within the incubator.
- Holding events that encourage communication between technology actors and startups.

Ethical Considerations

This study was conducted in accordance with accepted ethical standards for research in the social sciences. Participation in the questionnaire was voluntary, and respondents were informed of the purpose of the study. Confidentiality and anonymity of participants' responses were strictly maintained, and the data were used solely for academic research purposes.

Author Contributions

- **Dr. Abdellah Chachoua:** Conceptualisation of the study, literature review, and overall coordination.
- **Dr. Mohamed El Bachir Morkane:** Research design, data collection, and statistical analysis.
- **Prof. Ilyas Laidani:** Theoretical framework development and interpretation of results.
- **Prof. Mohammed Toufik Meziane:** Methodological guidance and critical revision of the manuscript.
- **Dr. Hakim Berradia:** Discussion of findings, policy implications, and final proofreading.

All authors have read and approved the final version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest regarding the publication of this article.

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