



Technological Innovation as a Strategic Pillar for Start-Up Sustainability: Insights into Strategic Adaptation and Global Market Entry – A Case Study of Double Power Machinery-

Radhia SMAILI^{1*}, Meriem SERARMA²

¹ COFIFAS Laboratory, Larbi Ben M'hidi University, Oum El Bouaghi (Algeria), radhia.smaili@univ-oeb.dz

² COFIFAS Laboratory, Larbi Ben M'hidi University, Oum El Bouaghi (Algeria), meriem.serarma@univ-oeb.dz

Received: 12/10/2025

Accepted: 01/04/2026

Published: 05/06/2026

Abstract:

This study examines technological innovation within start-ups and highlights its importance as a strategic choice, given its role as a foundational pillar for achieving growth, sustainability, and strategic adaptability. This importance is evident in the contemporary economic environment, which is marked by rapid and continuous changes and intense competitiveness. Within the Algerian context—characterized by limited access to formal financing and regulatory constraints—technological innovation emerges as a principal strategic tool for differentiation and long-term survival.

To achieve the study's objectives, a descriptive–analytical approach was adopted. The analysis focused on the start-up *Double Power Machinery*, a nationally recognized award-winning firm in technological innovation. Data were collected through a semi-structured interview with the company's founder, complemented by an analysis of internal documents, including innovation awards and patents. The collected data were subsequently subjected to thematic analysis following the procedures outlined by Braun and Clarke.

The findings reveal that the adoption of modern technologies—illustrated by the development of the mobile medical waste incinerator “COVID-19” and the INC-Pyrolyse system—significantly enhances the capacity of start-ups to improve their products and develop innovative, environmentally friendly solutions. Moreover, technological innovation strengthens their ability to adapt to market dynamics and pursue international market expansion.

Keywords: Technological Innovation; Start-Ups; Technology; Strategic Adaptation.

Jel Classification Codes : M13, O31.

*Corresponding author: Radhia SMAILI

1. Introduction

Start-ups have emerged as vital drivers of the modern economy in an era defined by technological advancement and digital transformation. They play a pivotal role in promoting innovation, creating employment opportunities, and contributing to sustainable development. These enterprises are characterized by their capacity to offer innovative solutions that align with rapidly evolving market demands and changing dynamics. Modern technology stands as one of the fundamental enablers for the development of start-ups, as it closely aligns with their inherently innovative nature and empowers them to attain their goals and accelerate growth.

Given the increasing competition within the start-up ecosystem, technological innovation has become a fundamental element for the success and sustainability of these ventures. It enables start-ups to enhance the quality of their products and services with reducing costs and improving responsiveness compared to traditional firms. Moreover, innovation supports improvements in operational efficiency, strengthens performance, and facilitates market expansion.

Like many countries worldwide, Algeria has recognized the importance of fostering innovation within start-ups. This recognition is reflected in the implementation of legal and regulatory frameworks aimed at encouraging ambitious youth to venture into entrepreneurship and access international markets.

Research Problem:

The central research problem addressed in this study is: **What is the role of technological innovation as a driver of strategic adaptation for emerging enterprises, given the constraints and challenges faced by the Algerian ecosystem? And how does the experience of Double Power Machinery reflect this reality through**

its innovative products that have succeeded in winning many awards?

To explore this issue, the study proposes the following hypotheses:

- Technological innovation contributes significantly to the growth, competitiveness, and strategic adaptability of start-ups in Algeria.
- Double Power Machinery serves as a representative model of technological innovation within Algerian start-ups.

Study Objectives:

The main objectives of this study are to:

- Provide a comprehensive overview of start-up enterprises;
- Highlight key concepts related to technological innovation;
- Examine the current state of technological innovation at the start-up Double Power Machinery as a strategic adaptation mechanism.

Methodology:

The applied component of this research relies on a **qualitative case study** of *DOUBLE POWER MACHINERY*, conducted through a content analysis of a semi-structured interview with the company's founder.

- **Data collection:** Data were obtained through a semi-structured interview with the founder, Mr. Fawzi Hezzam, aimed at gaining in-depth insights into the drivers, sources, and effects of technological innovation. This was complemented by an analysis of documents related to the company's national awards, its innovative products, the "startup" label, and the patent mentioned during the interview.
- **Data analysis:** The collected data were analyzed using **thematic analysis** following the steps proposed by Braun and Clarke, with an emphasis on the internal analysis of the firm. This process involved

repeated readings of the interview transcript, the generation of initial codes, the grouping of these codes into preliminary themes, and the refinement of these preliminary themes into final themes. This analytical approach enabled a deeper understanding of how technological innovation contributed to creating a sustainable competitive advantage in the environmental and industrial processing sector, as part of the company's strategic response to challenges such as the COVID-19 pandemic.

2. The Nature of Start-Ups

Start-ups are innovative and technology driven ventures that differ significantly from traditional enterprises. Today, they represent a fundamental pillar of global economic development. The concept of the start-up first emerged in the United States in the post-World War II period, in parallel with the rise of venture capital firms that, which primarily focused on technological innovations.

2.1 Definition of Start-Ups

- *Eric Ries* defines a start-up as “a human institution designed to create a new product or service under conditions of extreme uncertainty” (Ries, 2010).
- The English dictionary defines a start-up as “a small business that has just been launched.” The term itself comprises two components: *start*, referring to the idea of initiation, and *up*, indicating strong growth potential (Simoud & Dahmani, 2022, p. 89).
- Start-ups are also described as “organizations that reflect modernity and address the evolving needs of current market customers. They are characterized by four main attributes: recent establishment, innovation, rapid growth, and the presence of risk and uncertainty” (David B., 1994, p. 442).
- From a legal standpoint, Algerian legislation—specifically Article 11 of Executive Decree No. 20-254, issued on September 15, 2020, establishing a national committee for

awarding the labels ‘Start-Up,’ ‘Innovative Project,’ and ‘Business Incubator,’ and defining its duties, composition, and functioning—defines a start-up as any enterprise that meets the following criteria:

1. The company must be no older than eight (8) years;
2. Its business model must be based on innovative products, services, business models, or ideas;
3. Its annual turnover must not exceed the limit set by the national committee;
4. At least 50% of the company’s capital must be owned by natural persons, approved investment funds, or other entities already labeled as start-ups;
5. The company must demonstrate significant growth potential;
6. The number of employees must not exceed 250.

Based on the above, a start-up can be understood as an innovative idea—whether a product, service, or marketing method—adopted by an entrepreneur to solve existing problems. The objective is to establish a viable business model that is both profitable and scalable under conditions of uncertainty.

2.2 Characteristics of Start-Ups

Start-ups are innovative ventures distinguished by their creative nature and a unique set of attributes, including the following: (*Bentaleb & Redjem, 2024, pp. 23–24*)

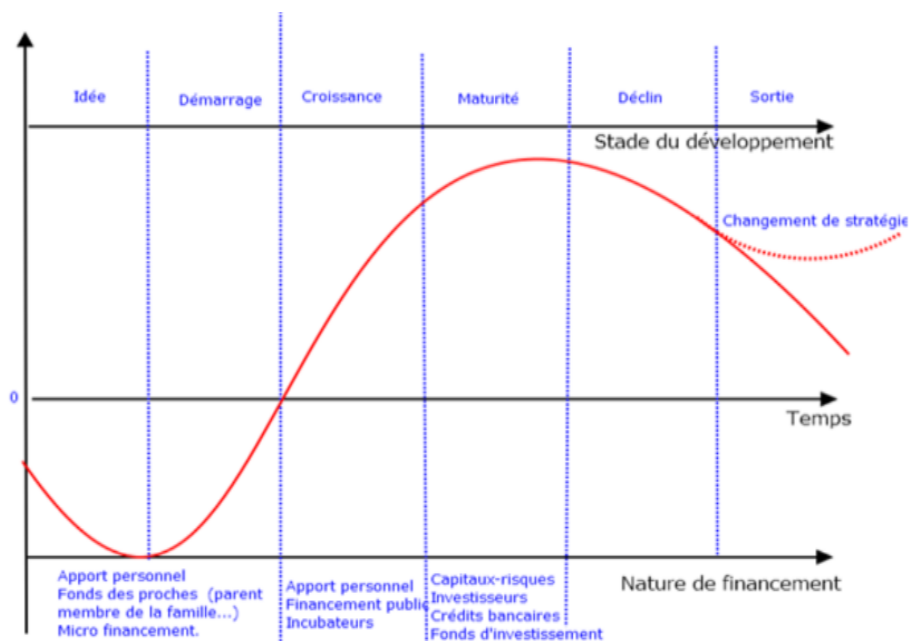
- **Organization:** A start-up is typically a newly established small enterprise characterized by a high degree of centralized decision-making and structural simplicity. This reduces administrative segmentation and maintains an informal organizational culture.

- **Ownership:** Start-ups are often owned and managed by a single individual—usually the founder—who is directly responsible for decision-making and oversight.
- **Innovation and Strategy:** Start-ups are primarily defined by technological innovation, which enables them to create added value and achieve a market-leading position ahead of competitors. They often adopt niche strategies aimed at capturing the largest possible market share, albeit with high levels of risk.
- **Financing:** In the early stages, entrepreneurs commonly rely on personal funds, as well as support from family and friends. As the business grows, they may seek funding from additional sources such as angel investors.
- **Rapid Growth:** According to Paul Graham in his 2012 essay “*How to Make Wealth*,” the defining trait of a start-up is its capacity for rapid growth. He emphasized that start-ups are specifically designed to scale quickly, contrasting the example of a barbershop—, which is limited by its local context—with that of a search engine like Google, which was built for expansive growth across a vast market. (Paul Graham - How to Make Wealth, 2012)
- **Risk:** Start-ups are built around unique and innovative ideas, which inherently carry uncertainty. As such, their implementation and ultimate success are not guaranteed and often come with significant risk. (Wassila, 2022, p. 08)

2.3 Stages of Establishing Start-Ups (Mohammed & Bouchama, 2016, pp. 43–44)

Start-ups go through several distinct phases during their development. The model proposed by Alfred Marshall is considered one of the earliest frameworks that outlines the various stages of establishing a start-up. This is illustrated in the following figure:

Fig.1. Life Cycle of a Start-Up



Source : Mohammed (Djelti, & al. 2016, p. 108).

- **Ideation (IDÉE):** This phase stems from an idea aimed at addressing a tangible need within a targeted customer segment. It marks the inception of the start-up.
- **Launch (DÉMARRAGE):** This is the initial phase of the business journey, often referred to as the “black hole” due to its extremely high failure rates. Approximately 70% of start-ups fail within the first two years, and up to 90% within the first five years. During this stage, start-ups typically rely on self-financing, including personal savings, support from family and friends, and individual investors. Traditional bank financing is usually unavailable at this point, making initial capital critically important.

- **Growth (CROISSANCE):** At this stage, the start-up begins to scale its activities by expanding products and services both horizontally and vertically in order to establish a solid market position. Start-ups are generally driven by an ambition for significant growth, with creativity and innovation serving as the primary engines of positive transformation in a competitive environment. Although the level of risk level decreases slightly, financial resources remain limited. Venture capital remains the preferred financing method, though some traditional funding may be utilized.
- **Maturity (MATURITÉ):** Some start-ups reach a saturation point in their markets, requiring them to find viable strategies to stimulate demand. This often involves differentiation and incremental innovation across all operations. During this phase, risks tend to decline, and start-ups may become eligible for loans from conventional banks. Venture capital continues to play a critical role in supporting further development at this stage.
- **Decline (DÉCLIN):** Considered a phase of organizational aging, this stage presents several challenges such as succession issues, ownership transfer, and wealth distribution.
- **Relaunch or Strategic Shift (SORTIE):** This is arguably the most crucial stage in a start-up's lifecycle. It requires the adoption of a strategic plan to ensure survival, most notably through innovation. Relaunch may efforts might include a major restructuring of the product model or the adoption of new market approaches to regain momentum.

2.4 The Economic and Social Importance of Start-Ups

Start-ups have become increasingly vital in both global and local economies. Their importance can be viewed from two primary dimensions:

2.4.1 Economic Importance

Start-ups occupy a prominent position in contemporary economic systems and are considered a key driver of sustainable economic development. They play a crucial role in strengthening national economies by supporting economic dynamics and facilitating growth. Additionally, start-ups often serve large enterprises, and their growing prominence enhances their reputation and, by extension, increases their market share.

As noted by Sylvain Ficom noted, the number of small businesses continues to rise in industrialized countries in response to the globalization of markets. He emphasized that the traditional mindset focused on expanding large-scale enterprises is becoming increasingly outdated. (*Lemamra & Wafa, 2021, p. 81*)

The economic impact of start-ups differs significantly between developed and developing countries. For example, in the United States, start-ups play a pivotal economic role. Silicon Valley, home to renowned technology companies such as Google, Facebook, and Apple, is a prime example: nearly 80% of start-ups in the region receive substantial investment, supported by approximately 298,800 angel investors.

Conversely, in Brazil, the influence of start-ups remains limited, accounting for just 0.4% of the country's GDP. There are roughly 10,000 start-ups in Brazil, of which only 25% receive investments from 6,450 angel investors. Moreover, around 50% of these start-ups cease operations within the first four years. (*Isabela, Amilton, & Kátia, 2015, p. 2201*)

2.4.2 Social Importance (*Ben Abdelrahman, 2023, p. 616*)

- Start-ups create employment opportunities for young people, particularly in the context of declining employment rates.

- They foster the development of individual capabilities, as these ventures require employees to assume diverse and specialized roles, drawing on their considerable skills and talents.

Furthermore, the social importance of start-ups lies in their contribution to sustainable development. Like all other businesses, they bear a responsibility to support the communities in which they operate. A start-up cannot thrive in a deteriorating social environment marked by poverty and ignorance; even if it generates profits, its existence would be short-lived. consequently, start-ups, like established firms, are increasingly engaging with social issues by supporting the new generation of idea-bearers. Former entrepreneurs, in particular, are expected to give back to society through their experience and resources. (*Hervé, Etienne, Guy, & co., 2001, pp. 93–94*)

2.5 Challenges Facing Startups in Algeria:

Startups in Algeria encounter a set of obstacles that hinder their operation and development. These challenges can be summarized as follows:

- The novelty and limited diffusion of the startup concept in Algeria.
- The absence of a functional ecosystem that effectively supports startups.
- Bureaucratic procedures and the lack of legislative and regulatory frameworks that facilitate and structure start-up activities.
- Persistent financing constraints, resulting in very slow growth rates for start-ups.
- Insufficient incubation, mentorship, and support mechanisms necessary for the success of such ventures.
- Weak public spending on scientific research, coupled with a significant disconnect between research institutions and universities, on the one hand, and market needs and the business environment in Algeria, on the other.
- The limited number of business incubators, their geographic distance

from urban centers, and their misalignment with international incubator models (Zamit & Belhadef, 2024, p. 19).

3. The Nature of Technological Innovation

Start-ups fundamentally rely on technological innovation. To achieve leadership and sustainability, they must foster an innovative and creative mindset while expanding the scope of technological research and development.

3.1 Definition of Technological Innovation

- The Organisation for Economic Co-operation and Development (OECD) defines technological innovation as: “The totality of scientific, technical, commercial, and financial steps necessary for the successful development and marketing of new or improved industrial products, the commercial use of new or improved processes, equipment, or services, or the introduction of a new method in social services. Research and development represent just one stage in this process.”
- Joseph Schumpeter defined technological innovation as “The creation of new combinations, which may include the introduction of a new good into the market, the improvement of an existing good, the implementation of a new method of production, the opening of a new market, the conquest of a new source of raw materials or semi-finished goods, and the reorganization of an industry.”
- Fulmer described technological innovation as “A type of modernization and originality in the product—technological innovation is a continuous process of improving existing products and launching new ones that reflect the latest technological trends and meet evolving customer needs.” (Mohammed & Safaa, 2017, p. 281)
- According to Paul, Baltes, Smelser, & Neil (2001, p. 15499): “Technological innovation is the successful implementation—

whether in commerce or management—of a new technological idea within the enterprise. Innovations differ from inventions, technologies, and research, though they may arise from any of them.”

Based on the above definitions, technological innovation can be understood as the creation of new technology-related ideas—manifested in newly developed or improved products or services—that can be implemented in real-world contexts.

3.2 Types of Technological Innovation

Technological innovation can be classified according to various criteria, with two primary frameworks based on the nature and degree of innovation:

3.2.1 Based on the Nature of Technological Innovation

According to the nature of the innovation, technological innovation is divided into product innovation and process innovation. Typically, a start-up begins with product innovation based on consumer needs, followed by process innovation once the product reaches market saturation. (*Daesu & Yongwoon, 2024, p. 02*)

- **Product Technological Innovation:** This refers to the introduction of a new product that differs from existing offerings, or the enhancement or development of an existing product. It plays a vital role in sustaining business activity by stimulating customer demand and boosting sales. It also serves to replace existing products in the market.
- **Process Technological Innovation:** This involves introducing changes to work methods, equipment, and workflows to enhance production efficiency or increase the output of goods and services. Essentially, it is the process of identifying and seizing

opportunities for new or improved products, processes, and services.

3.2.2 Based on the Degree of Technological Innovation

According to the degree of innovation, technological innovation can be categorized into incremental innovation and radical innovation:

- **Incremental Technological Innovation:** This refers to gradual improvements or modifications to the core components of a product. It does not require deep or novel knowledge and generally entails low costs, making it accessible even to regular employees. It often begins with a small idea that is refined and leveraged into a larger opportunity for sustained profit due to its continuous and cumulative nature. (Dbi & Barhoum, 2018, p. 203)

Incremental innovation is defined as “a large number of small changes that lead to continuous improvement. It is not disruptive but rather evolves within the existing framework.” (Najm Aboud, 2003, p. 111)

- **Radical Technological Innovation:** This type of innovation introduces fundamental and transformative changes to products or production methods, with the aim of achieving market dominance and enhancing competitive advantage. It often revolutionizes the market and requires advanced skills, new knowledge, and cutting-edge technologies to achieve optimal performance. (Bouali & Amimer, 2023, p. 512)

Radical innovation is difficult to implement and adopt, as it typically requires long development periods and substantial financial investment. (Khadish & Merabti, 2023, p. 156)

3.3 Sources of Technological Innovation

Technological innovations are often the result of meticulous planning, sustained effort, and continuous work. However, new products, innovative processes, or improvements are sometimes developed without prior planning, emerging instead from the exploitation of unexpected opportunities or circumstances. According to *Peter Drucker* in his book ***Innovation and Entrepreneurship***, the primary sources of innovation include the following: (Mohammed & Safaa, 2017, pp. 284–285)

- **Unexpected Events:** Many companies have developed new products through accidental discoveries made by research teams or engineers. In some cases, such innovations have significantly increased profits. For instance, *Don Cullen of Transmet Corporation* created a type of aluminum foil used in roofing by chance. Similarly, the accidental discovery of plastic hardening has yielded remarkable results today.
- **Incongruities:** Discrepancies between anticipated results and actual outcomes—whether in outcomes, performance, or plans—can create opportunities for innovation. These gaps often lead to important technological developments.
- **Process Requirements:** The successive stages of production that lead to, the final product, serve as fertile ground for skilled engineers and technicians. By closely monitoring these stages—especially changes occurring as inputs are transformed into outputs—innovative products and processes may emerge.
- **Market or Industry Changes:** Transformation within economic sectors, driven by technological advancement, industry evolution, and changing consumer preferences, necessitate innovation. In the contemporary economy, creativity and innovation are among the most valuable assets. Without novel and inspiring ideas, businesses risk obsolescence.
- **New Knowledge:** The rapid expansion of scientific knowledge has generated a wide range of new products, especially in

telecommunications and electronics. These innovations stem from new ideas and knowledge applied through various methods. Across disciplines, the volume of knowledge continues to grow at unprecedented rates, thereby increasing opportunities for innovation.

- **Demographic Changes:** Variations in population size, geographic distribution, age structure, occupations, income levels, educational levels, and employment rates create significant opportunities for technological innovation , particularly in key sectors such as education, healthcare, and housing.

3.4 Importance of Technological Innovation (*Hariri & Keifani, 2024, p. 298*)

- **Enhancing Financial Performance:** Technological innovation improves institutional productivity, market share, sales, profits, and overall competitiveness.
- **Developing Human Capital:** Continuous training programs in modern knowledge and technologies contribute to skill development and workforce advancement.
- **Improving Customer Service:** By offering flexible and timely services, companies can respond more effectively to evolving customer needs.
- **Temporal Excellence:** Technological innovation enables rapid responses to market changes and customer demands.
- **Achieving Efficiency and Effectiveness:** By promoting a culture of continuous improvement, innovation enhances organizational performance and adaptability.

3.5 Measuring Technological Innovation

Measuring technological innovation requires a set of indicators that help form an accurate and comprehensive picture for assessment purposes. Empirical research on technological innovation emphasizes the use of three main types of quantitative measures for innovation

activities, which, when combined, tend to yield relatively similar results. The key indicators are as follows: (Aouarib, 2022, pp. 50–51)

- **Expenditure on Research and Development (R&D):** This includes the total amounts spent on R&D activities, whether at the institutional level or by the state. It serves as a primary indicator of investment in technological innovation. However, such data often lack accuracy and comprehensiveness in many countries.
- **Number of Patents:** Patent databases are a valuable source of information on technological innovation. The number of patents granted provides a clear indication of the level of investment in R&D. A patent is the only formally recorded indicator available through national intellectual property offices and databases.

While patents are commonly used as indicators of technological innovation, they do not always reflect the actual level of innovation. A high number of patents does not necessarily imply the presence of valuable or economically significant innovations. Practices such as "patent thickets", which are intended to obstruct competition may distort the picture. Genuine technological innovation is concerned with the practical application of new ideas and technologies to develop products and services that contribute to economic growth and human well-being. Therefore, a large number of patent filings does not necessarily correspond to high levels of technological innovation.

- **Technology Innovation Surveys:** These surveys are considered an effective tool for measuring innovation levels across different sectors and organizations. Based on comprehensive evaluations, they represent one of the most reliable sources of information, as they provide direct measures of innovation output. Survey conductors establish data collection procedures and define target industries, enterprises, and countries.

In practice, however, technological innovation surveys face a major challenge, as there is no universally accepted standard for what constitutes a genuine innovation. As a result, these surveys may suffer from inaccuracies due to varying interpretations of innovation, which can lead to the inclusion of innovations of differing levels of significance. Additionally, limited data availability in many countries and the involvement of multiple stakeholders in the innovation process makes it difficult to accurately quantify innovation outcomes.

4. Case Study: The Start-Up "DOUBLE POWER MACHINERY"

This section presents a case study of the start-up DOUBLE POWER MACHINERY, located in the Wilaya of Oum El Bouaghi, Algeria. The study is based on oral interviews conducted with the founder, Mr. Fawzi Hezzam .

4.1 Overview of the Start-Up "DOUBLE POWER MACHINERY"

DOUBLE POWER MACHINERY is an industrial company specializing in the manufacturing of incineration equipment, waste treatment systems, and emission treatment plants. The company was established in 2016 and was officially obtained the "Start-Up" label in 2023. It is fully self-financed (100% equity-funded) and stands as a leading enterprise in its field. The company also maintains strategic partnerships with firms in China and Turkey.

The following table summarizes the key points discussed during the interview with the founder.

Table 1. Interview Results with the Founder of DOUBLE POWER MACHINERY

Questions	Answers
What is your field of work?	DOUBLE POWER MACHINERY LLC is an industrial start-up specializing in the design and manufacture of waste incineration equipment and emission treatment plants, as well as chemical and mechanical treatment stations for polychlorinated biphenyls (PCBs).
How did the idea for your company originate?	I initially had the idea to create a business in cleaning and cosmetic products. During my search for the necessary machinery, I began considering the machinery trade and started importing various production lines, selling them as-is. This later transitioned into local manufacturing through a Chinese partnership, followed by independence, and ultimately into manufacturing and innovation after the COVID-19 pandemic, which highlighted the need for eco-friendly incineration devices.
Did you receive the "Start-Up" label?	Yes, we received the "Start-Up" label on February 9, 2023.
What is the goal of your company?	The goal of our company is to develop innovative and sustainable solutions in the field of industrial waste management and emission treatment.
Is the company individually, or jointly owned?	The company is jointly owned by two partners, both of whom have hold management rights.
How did you secure funding? Did you face difficulties?	Initially, the company was 100% self-funded. Later, we secured a private partner. We faced several difficulties in obtaining funding.
Did any institutions (incubators or accelerators) support you?	No, we did not receive any support from incubators, accelerators, or other institutions.
What is the economic and social role of your company?	Our company plays a pivotal role in supporting the economy through industrial innovation and international expansion. We create job opportunities and contribute to social development by providing sustainable environmental

Questions	Answers
	solutions that protect public health and maintain ecological balance. We also collaborate with universities and research centers to support scientific research in environmental technology and develop local expertise.
What are your future prospects, given the recent encouragement from the government and the adoption of policies supporting start-ups?	Despite challenges related to the lack of financial support and a weak supporting environment, our company adopts a strategy based on innovation, financial independence, and expansion. Our future prospects include : • Expanding into local and international markets, particularly in countries with strict waste and emission treatment policies. • Conducting advanced research in collaboration with universities and educational institutions to develop sustainable solutions with lower operational costs. • Contributing to national environmental goals by providing eco-friendly solutions that support the green economy. • Collaborating with research institutions and industrial partners to create a support system based on knowledge and resource exchange. • Participating in international exhibitions and conferences to strengthen the company's position and attract new investment opportunities.
What is your assessment of the start-up ecosystem in Algeria?	The start-up ecosystem in Algeria is evolving, but still faces significant challenges that hinder its ability to reach its full potential. While the government is willing to support this sector, structural and financial obstacles remain. For start-ups to succeed, fundamental reforms are needed in financing methods, administrative procedures, and the overall business environment.
What technological innovation is your company based on?	The company has achieved several innovative milestones, including: • <i>Mobile Medical Waste Incinerator "COVID-19"</i>: Our first pioneering project in the field of mobile waste incineration, developed in response to the COVID-19 pandemic. This technology won first place in the National Innovation Award for Small

Questions	Answers
	and Medium Enterprises in 2021 under the Green Economy category. • <i>L'INC-Pyrolyse</i>: A new technology for waste disposal and valorization through pyrolysis, which won third place in the National Innovation Award for Small and Medium Enterprises in 2022. • <i>PCB Oil Decontamination and Dechlorination Station</i>: Our latest innovation, patented in December 2024, provides an effective solution for treating and neutralizing PCB-contaminated oils, contributing to industrial pollution reduction and environmental sustainability.
How did you discover this innovation? What are its sources?	The innovation emerged after years of gaining experience and expertise. The urgent need arose to address the danger of transporting COVID-19 waste from hospitals and quarantine centers to distant incineration sites. We came up with the idea of creating a mobile waste incinerator, our first innovation. It was lightweight, energy-efficient, highly effective, and emitted low pollutants. This innovation helped eliminate the risk of medical waste spreading between neighborhoods, as it allowed disposal to take place at the site where it was generated.
What type of technological innovation did your company focus on (product/process, incremental/radical) ?	Our company focused on product innovation , specifically the development of mobile waste incinerators, pyrolysis systems (INC-Pyrolyse), and PCB oil treatment stations. These innovations are also considered incremental innovations , as they were built upon existing technologies (such as incinerators) but introduced innovative features such as reduced weight, high efficiency, and low emissions, along with noticeable improvements in performance and environmental impact.
How did you determine that this innovation would have a market?	We knew the innovation would find a market based on the urgent and realistic need in the field, particularly during the COVID-19 pandemic. It was a direct response to a clear and pressing market need, confirming the existence of actual demand.
Does your company invest in research	Yes, our company places great importance on research and development (R&D) as a fundamental driver of innovation

Questions	Answers
and development (R&D)? 	and improving its technologies in waste management and emission treatment. Despite financial challenges and lack of sufficient government support, the company relies on a self-investment strategy in R&D to ensure continuous innovation.
Do you have patents or new technological innovations?	Yes, our company has achieved a major milestone by securing two patents in December 2024, while a third patent was filed in March 2025 and is currently under review.
Have your technological innovations provided a competitive advantage?	By focusing on technological innovation, our company has been able to differentiate itself from competitors by developing advanced environmental solutions. The improvement of waste incinerators and emission treatment plants has made our products more efficient and sustainable compared to traditional solutions. Additionally, owning patents provides legal and technical protection against imitation, which has strengthened our position in the market and established us as a leader in the waste management and environmental technology sector.
What obstacles did you face in technological innovation?	• Despite our success in achieving outstanding technological innovations, this journey has not been without challenges. The main obstacles include : • The absence of real governmental support for start-ups and a lack of dedicated funding for R&D, forcing the innovation process to rely mainly on self-financing. • Difficulty in securing investments for research projects and technological development. • Lengthy and complex patent registration processes, delaying the protection of innovations and slowing down their commercialization. • Limited specialized facilities available for testing and developing new technologies. • Customs barriers, which make it difficult to market innovative products globally, despite technological superiority. • The need for specialized expertise in certain technical fields, given the limited availability of qualified human resources locally.

Questions	Answers
What is your participation in exhibitions, forums, and seminars, and how has it influenced your company, especially regarding technological innovation?	Our company has participated in national and international forums, environmental and industrial exhibitions, which gave us the opportunity to showcase our technological innovations and present our sustainable solutions for waste management. This opened the door to collaboration in research and development and business expansion. The participation in innovation and technology competitions, such as the "National Innovation Award for Small and Medium Enterprises," has been particularly significant.
How do you contribute to supporting scientific research through your field experience?	• Our company contributes to scientific research through its field experience in waste management and environmental technology by: • Providing research and training opportunities for university students in engineering and environmental fields, allowing them to apply their academic knowledge in real-world settings through partnerships with universities. • Collaborating with research centers to foster technological and industrial innovation, conducting field studies, and performing practical experiments to develop waste treatment and emission reduction technologies. • Offering a practical example of how scientific research can be integrated into the development of effective industrial solutions through the patents we hold. • Participating in scientific conferences to share our field experiences with researchers and academics, exchanging knowledge about the best environmental practices and modern technologies, enriching scientific research in waste management and green technologies.

Source: Prepared by the researchers based on the interview with the founder of "DOUBLE POWER MACHINERY."

4.2 Analysis of Interview Findings:

The experience of *DOUBLE POWER MACHINERY* provides concrete and practical evidence of the vital role that technological innovation plays in the survival and competitiveness of Algerian startups, particularly in the face of financial and environmental challenges.

Strategic/Adaptive Impact	Case-Specific Instance (Double Power Equipment)	Outcome (Technological Innovation)
The firm demonstrated exceptional resilience through an immediate response to a global pandemic, leveraging industrial expertise into a sustainable solution for public health.	Development of the "COVID-19 Mobile Medical Waste Incinerator," which secured first place in the 2021 National Award for Innovative SMEs (Green Economy category).	Enhancing Crisis Resilience (Product Innovation)
The firm focuses on Radical Innovation within the local context and Incremental Innovation to improve efficiency, facilitating the creation of a Niche Market.	- Development of the L'INC-Pyrolyse system. - Decontamination and dechlorination plant for PCB oils. - 2024 Patent Filing.	Generating Sustainable Competitive Advantage (Product & Process)
This underscores that award-winning technological innovation served as the primary driver for growth, reducing dependency on inaccessible institutional support.	100% self-funded at inception, relying on private partnerships without support from incubators or accelerators.	Overcoming Financing Constraints (Self-Reliance)
Technological innovation acts as a strategic bridge,	Strategic plans for expansion into	International Expansion &

enabling Algerian start-ups to transition from constrained local markets to global competition in advanced industries.	international markets with stringent waste management policies and collaborations with research centers.	Knowledge Partnerships
--	--	------------------------

4.3 Discussion of Findings:

The findings of the *Double Power Machinery* case study support the hypothesis that technological innovation is a major contributor to the growth and competitive capacity of Algerian start-ups.

• **Innovation as a strategic adaptation mechanism in emerging markets:**

This finding aligns with the entrepreneurship literature, which suggests that startups in emerging economies-characterized by weak institutional environments, such as Algeria, where access to formal financing is limited-tend to rely more heavily on both radical and incremental innovation as mechanisms of strategic adaptation, consistent with Schumpeter’s theory of *creative destruction*.

• **The development of mobile waste-incineration devices during the COVID-19 health crisis** exemplifies the firm’s ability to seize opportunities arising from urgent societal needs, a phenomenon described by Peter Drucker as one of the key sources of innovation.

• **Shifting from product innovation to process innovation:**

The company initially focused on product innovation (mobile incinerators and pyrolysis systems), which is typical of firms in the growth stage (*Croissance*) as they seek to secure their market share. As the company expands, it is expected to increasingly emphasize process innovation aimed at improving operational efficiency and reducing production costs—an evolution consistent with the later stages of a startup’s life cycle.

• **The socio-economic impact of innovation :**

The impact of the company's innovations extends beyond product enhancement to the provision of sustainable environmental solutions, such as PCB-oil treatment and medical-waste management. This direct link between innovation and social benefit reflects the growing role of startups in supporting the Sustainable Development Goals (SDGs) and aligns with the social importance of innovative ventures emphasized in the literature.

Accordingly, the experience of *Double Power Machinery* suggests that Algerian startups have the potential to become drivers of economic transformation if they focus on developing technological solutions that are both locally rooted and globally competitive, thereby overcoming traditional constraints related to financing and institutional support.

5. Conclusion:

The study concludes that technological innovation enables Algerian startups to develop new products and services, enhance operational efficiency, and consequently build competitive advantage and strong capacity to adapt to rapid changes. This makes innovation a decisive factor for survival and strategic expansion within an economic environment characterized by financial and regulatory constraints.

Through the case study of **S.A.R.L. DOUBLE POWER MACHINERY**, it has been demonstrated that:

• **Innovation serves as an immediate response to crises:**

The Company's success in developing a mobile incinerator during the COVID-19 pandemic illustrates the capacity of technological innovation to generate strategic resilience and respond effectively to unforeseen market needs.

• Innovation opens new markets:

By focusing on green-economy innovation and developing advanced solutions such as PCB-oil treatment systems, the company has gained a unique competitive advantage, paving the way for expansion into international markets with stringent environmental standards.

Accordingly, the main finding of this study is that Algerian startups can evolve into leading industrial companies, moving beyond traditional digital-service models. It also highlights that successful technological innovation can compensate for weak funding mechanisms and limited institutional support, making this case study particularly valuable for policymakers seeking to strengthen a sustainable and globally competitive entrepreneurial ecosystem.

Recommendations :

- Start-ups should adopt technological innovation as a strategic priority, and the government should support this orientation through clear incentive policies and effective regulatory reforms.
- Specialized financing mechanisms should be established to support research and development in technological fields.
- National entrepreneurship programs focused on human capital development should be strengthened.
- The outcomes of scientific research and technological innovation should be valued and promoted.
- Policymakers and entrepreneurs should rely on successful business models that focus on technological innovation as a cornerstone for growth and sustainability.

6. Bibliography List :

Abdelkader, B., & Fadila, A. (2023). *The Impact of Technological Creativity on Competitive Strategies—A Field Study on a Group of Algerian Economic Enterprises*. *Journal of Economic Notebooks*, 14(02), 507-525.

- Ali, D., & Asma, B. (2018). *The Specificity of Technological Innovation in Algerian Small and Medium Enterprises. Journal of Law and Humanities—Special Edition*, 35(01), 194-213.
- Ben Fadel, W. (2022). *Doctoral Thesis: Mechanisms for Developing the Start-Up Sector in Algeria (Analytical Study). Faculty of Economic Sciences, Commercial and Management Sciences, Tlemcen, Algeria: Abu Bakr Belkaid University.*
- BENTALEB, S., & REDJEM, K. (2024). *Digital Marketing in Algerian Start-Ups: A Case Study of Redjem Studio. Algerian Journal of Economics and Business Studies*, 04(02), 20-28.
- Daesu, K., & Yongwoon, G. (2024). *Effect of Korean SMEs' Technological Innovation on Transaction Dependence: Focused on Moderating Effect of Resource Competency. Journal of Open Innovation: Technology, Market*, 10(04), 1-8. doi: <https://doi.org/10.1016/j.joitmc.2024.100421>
- David B., A. e. (1994). *New-Firm Startups, Technology, and Macroeconomic Fluctuations. Small Business Economics*, 06(06), 439-449.
- ERIC-RIES. (2010, June 21). *What is a Startup?* Retrieved from <https://www.startuplessonslearned.com/>, (Consulté le 21/02/2025).
- Fawzia, H., & Shahida, K. (2024). *Strategic Vigilance as an Effective Tool for Enhancing Technological Innovation: A Case Study of the Agricultural Equipment Manufacturing Company CMA in Sidi Bel Abbes. Journal of Economic Promises*, 10(03), 292-306.
- Ghada, K., & Sana, M. (2023). *The Impact of Technological Innovation on Achieving Competitive Superiority—A Case Study of the National Algerian Bank in Constantine. Journal of Human and Social Sciences*, 09(02), 171-152.
- Hervé, A., Etienne, K., Guy, P., & others. (2001). *From Traditional Enterprise to Start-Up: The New Paradigms. Paris: Editions d'Organisation.*
- Isabela, M., Amilton, A., & Kátia, A. (2015). *The Design and Technological Innovation: How to Understand the Growth of Start-Up Companies in Competitive Business Environments. Procedia Manufacturing*, 3(2015), 2199-2204. doi: <https://doi.org/10.1016/j.promfg.2015.07.361>
- Lamamra, S., & Tabinat, W. (2021). *Start-Ups: Successful Global Models and the Reality of Start-Ups in Algeria—Challenges and Obstacles. Journal of Economics and International Trade*, 03(01), 80-95.

- Mohammed, D., & Bouchama, C. (2016). State of Incubators in Algeria: Case of INTTIC Incubator in Oran. *Journal of Strategy and Development*, 06(10), 36-65.
- Nadia, A. (2022). Doctoral Thesis: The Role of Research and Development in Activating Technological Creativity—A Field Study on a Sample of Algerian Industrial Enterprises. Faculty of Economic and Commercial Sciences and Management Sciences, University of Kasdi Merbah, Ouargla.
- Najem, A. (2003). *Innovation Management (Concepts, Characteristics, and Modern Practices)*. Dar Wael for Publishing and Distribution, Amman, Jordan.
- Neriman, B. A. (April, 2023). Towards a Knowledge Economy and the Establishment of Start-Ups in Algeria. *Algerian Journal of Research and Studies*, 06(02), 609-627.
- Paul Graham. (2004, MAY). How to Make Wealth? Retrieved from <https://www.paulgraham.com/wealth.html>, (Consulté le 25/02/2025).
- Paul, B., Baltes, J., Smelser, & Neil, J. (2001). Technological Innovation. In *International Encyclopedia of the Social & Behavioral Sciences*, 21, 15498-15502.
- Qureshi, M., & Bayadi, S. (2017). Technological Innovation in Enterprises: Its Types, Sources, and Influencing Factors. *Journal of Law and Humanities—Economic Edition*, 34(01), 280-287.
- Simoud, L., & Dahmani, S. (October, 2022). Artificial Intelligence: A Digital Technology Leading to the Innovation of Emerging Educational Experiences in Algeria—The Case of Ankedy Company. *Journal of Media and Communication Studies, Digitalization*, 02(02), 87-97.
- Yagoub, A. B., Oum El-Khir, B., & Mohamed, L. (2024). The Role of Technological Innovation in the Success of Start-Ups in Algeria. *International Journal of Professional Business Review*, 09(05), 01-24. doi: <https://doi.org/10.26668/businessreview/2024.v9i5.4708>
- Zamit, B. A., & Belhadef, R. (2024). Startups in Algeria between reality challenges And Developement requirements. *revue dafatir bodkas*, 13(02), 01-23.