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Organization and Valorization of Scientific Research

Intended for Master 2 Students
In Biodiversity and Plant Physiology

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List of Abbreviations

ASF: Algerian Startup Fund.

AAPI : Agence Algérienne de Promotion de l'Investissement.

ANVREDET : Agence Nationale de la Valorisation des Résultats de la Recherche et du Développement Technologique.

CATI : Centres d'Appui Technologique et de l'Innovation.

CDER : Centre de Développement des Energies Renouvelables.

CNRC : Centre National du Registre du Commerce.

CRTI : Centre de Recherche en Technologies Industrielles.

DGRSDT : Direction Générale de la Recherche Scientifique et du Développement Technologique.

GERD: Gross Domestic Expenditure on Research and Development.

IMRaD: Introduction - Methods - Results - Discussion.

INAPI : Institut National Algérien de la Propriété Industrielle INRAA : Institut National de la Recherche Agronomique d'Algérie.

OECD : Organisation de Coopération et de Développement Économiques R&D : Recherche et Développement.

UNESCO: United Nations Educational, Scientific and Cultural Organization.

WIPO: World Intellectual Property Organization.

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Introduction

History of Scientific Research

Scientific research in biology has evolved from early descriptive natural history into a rigorous experimental discipline grounded in observation, hypothesis formulation, and empirical validation (Mayr, 1982; Russell, 2010). Initial biological inquiry primarily focused on the classification and description of living organisms, particularly within the framework of Aristotelian natural philosophy and later Linnaean taxonomy (Bowler, 2003).

Subsequent conceptual and methodological breakthroughs-such as the development of cell theory, Darwinian evolutionary theory (Darwin, 1859), the emergence of microbiology (Pasteur, 1861), and the rise of molecular biology in the twentieth century (Watson et Crick, 1953)-transformed biology into a modern experimental science based on causal explanation and quantitative analysis.'

In contemporary biology, research extends beyond direct observation to include controlled experimentation, the use of model organisms, and computational approaches integrating molecular, organismal, and ecological scales (Alberts et *al.*, 2015). Methodologically, the history of biological research reflects a progressive refinement in experimental control, measurement precision, and statistical inference (Fisher, 1925). This evolution enabled the systematic testing of causal relationships across physiology, genetics, microbiology, and biochemistry.

Modern biological research thus occupies the intersection of historical naturalism and experimental rigor, combining field observation, laboratory experimentation, and data-driven modeling within an integrated scientific framework (Mayr, 1982).

Purpose of Research

The primary aim of biological research is to understand life processes, elucidate underlying mechanisms, and generate reliable, reproducible knowledge about living systems across multiple levels of organization-from molecular and cellular systems to populations and ecosystems (Alberts et *al.*, 2015).

In addition, biological research addresses applied societal challenges, including disease prevention, diagnostic innovation, therapeutic development, biodiversity conservation, and agricultural improvement (National Research Council, 2009). Consequently, biology fulfills both a theoretical function (knowledge production) and an applied function (problem-solving in health, environment, and agriculture).

A central epistemological objective of scientific research is the production of testable and falsifiable explanations, rather than purely descriptive accounts (Popper, 1959). This involves hypothesis formulation, prediction derivation, and empirical validation. Scientific knowledge is inherently cumulative, as findings are continuously refined, replicated, or revised through subsequent investigations (Kuhn, 1962).

Types of Research

Biological research can be classified according to its objectives, methodologies, and analytical contexts.

A first distinction is between basic research**,** which aims to expand fundamental scientific knowledge, and applied (or translational) research**,** which seeks to transform this knowledge into practical solutions, technologies, or medical interventions (Stokes, 1997). In biology, this continuum is particularly evident in areas such as molecular genetics and biotechnology.

A second classification concerns the research environment:

- In vivo research involves studies conducted within living organisms, enabling analysis of systemic physiological responses.
- In vitro research is conducted outside the organism (e.g., cell cultures), allowing controlled investigation of specific biological mechanisms.

In silico research relies on computational modeling and bioinformatics to analyze biological systems and predict functional interactions (Lynch, 2008).

A third distinction relates to methodological logic:

- Experimental research manipulates variables under controlled conditions to establish causal relationships.

- Descriptive research documents biological structures or patterns without experimental manipulation.
- Field research investigates organisms in natural environments, while laboratory research prioritizes control and reproducibility.

In practice, robust biological studies often integrate multiple approaches to balance ecological validity with experimental precision (Alberts et *al*., 2015).

Phases and Steps of the Research Process

The biological research process is systematic but often iterative rather than strictly linear (Creswell, 2014). It begins with observation and literature review, followed by the identification of a research problem. Examples may include pathogen resistance mechanisms, plant physiological responses to environmental stress, or genetic mutation effects on protein function.

Researchers then formulate a hypothesis and design a methodological framework. This includes defining independent, dependent, and control variables; selecting biological models; and establishing sampling and data collection strategies. Rigorous experimental design typically incorporates control groups, replication, and standardized measurement procedures to ensure validity and reliability (Fisher, 1925).

Data collection is then conducted in laboratory, field, or computational settings. The resulting data are analyzed using statistical or qualitative methods to assess whether they support or refute the hypothesis. Finally, findings are interpreted, documented, and communicated through scientific publications, where they become subject to peer review and scientific validation (Day et Gastel, 2012).

For a master's student in biology, the research process may be summarized as follows:

- Identify a biological problem or knowledge gap through observation and literature review.
- Formulate a research question and testable hypothesis.
- Select an appropriate methodological approach (in vivo, in vitro, in silico, or field-based).
- Design the experimental protocol, define variables, and establish controls.
- Collect data using standardized and reproducible procedures.

- Analyze and interpret results in relation to the hypothesis.
- Communicate findings through a dissertation, report, or peer-reviewed article.

I- Organization of Scientific Research

The organization of scientific research refers to the systematic coordination of resources, processes, and governance structures that enable the production of new knowledge (UNESCO, 2021). It constitutes a complex ecosystem that connects governments, universities, research institutes, private sector organizations, and international bodies (UNESCO, 2021). A well-structured research system ensures that scientific activity is rigorous, ethical, and aligned with societal priorities, including sustainable development and innovation (UNESCO, 2021; WIPO, 2025).

At the master's level, understanding this ecosystem is essential for transitioning from a passive consumer of knowledge to an active contributor to original research.

I-1- Conditions for Scientific Production

Scientific production encompasses a range of tangible outputs, including journal articles, patents, datasets, technical reports, and theoretical models. These outputs depend on an environment that fosters inquiry, experimentation, and dissemination. Such an environment is commonly analyzed in terms of two interdependent sets of conditions: material conditions and intellectual conditions (OECD, 2025) (Table 1).

Table 1: Key Material and Intellectual Conditions for Effective Research Systems

Condition Category	Key Components	Main Function
Material conditions	Funding, infrastructure, human resources	Provide the physical, financial, and operational capacity for research
Intellectual conditions	Education and training, access to information, academic freedom	Ensure competence, critical thinking, and autonomy in knowledge production

Material conditions provide the resources and logistical frameworks without which research cannot be conducted at scale (UN DESA, 2025; UNESCO, 2021). Intellectual conditions, by

contrast, determine the quality, originality, and integrity of the scientific process (UNESCO, 2021).

I-1-1-Material Conditions

Material conditions refer to the tangible and organizational resources that make research activities feasible (UN DESA, 2025). They shape the scale, complexity, and continuity of scientific projects over time (UNESCO, 2021). Three core components are generally identified: funding, infrastructure, and human resources (UNESCO, 2021; OECD, 2025).

I-1-1-1- Funding

Funding is a primary determinant of a country's research and innovation capacity and is often measured by gross domestic expenditure on research and development (GERD) as a percentage of gross domestic product (GDP) (OECD, 2025). This indicator - commonly referred to as R&D intensity-captures the overall national investment in research (OECD, 2025; WIPO, 2025). Recent analyses indicate that global R&D expenditure has continued to increase despite economic and geopolitical challenges, reaching approximately 2% of global GDP (WIPO, 2025). However, significant disparities persist: leading innovation economies invest more than 4-5 % of GDP, whereas many low- and middle-income countries remain below 1% (OECD, 2025; UN DESA, 2025).

The main sources of research funding typically include public budgets (e.g., national research councils and government ministries), private-sector investment, higher education funding, and international or philanthropic contributions (UNESCO, 2021; UN DESA, 2025). Public funding tends to prioritize basic research and long-term capacity building, while private investment is often directed toward applied research and commercialization (UNESCO, 2021). For researchers, this context highlights the importance of developing skills in grant writing, project budgeting, and participation in multi-partner funding schemes.

From a pedagogical perspective, students may distinguish between three main types of funding: core institutional funding, competitive project-based funding, and contract research funding (UNESCO, 2021; UNDESA, 2025).

I-1-1-2- Infrastructure

Research infrastructure encompasses the physical and digital facilities required to conduct experiments, collect data, and analyze results (UNESCO, 2021). This includes laboratories, specialized equipment, experimental sites, computing facilities, and digital platforms (UNESCO, 2021). In many scientific disciplines, access to advanced instrumentation determines the boundaries of what can be empirically investigated.

Digital infrastructure has become increasingly critical with the rise of data-intensive research and open science practices (UNESCO, 2021; UNESCO, 2021a). It includes reliable internet connectivity, secure data storage systems, data repositories, and collaborative platforms that support remote teamwork and reproducible research workflows (UNESCO, 2021a; EUA, 2025). Inadequate or outdated infrastructure often constrains researchers to theoretical or secondary analyses, thereby limiting their ability to produce original empirical contributions (UNDESA, 2025).

At the institutional level, effective infrastructure management requires clear maintenance strategies, shared-use policies, and transparent rules governing access and cost-sharing among research teams.

I-1-1-3- Human Resources

Human resources constitute the core of the research system, as it is ultimately individuals—rather than institutions-who formulate research questions, design methodologies, and interpret results (UNESCO, 2021). Modern research organizations depend on a structured yet collaborative workforce that includes professors and principal investigators, postdoctoral researchers, doctoral and master's students, engineers, technicians, and administrative staff (UNESCO, 2021).

The availability of highly qualified personnel - often measured by indicators such as the number of researchers per thousand employees - is a key determinant of scientific capacity (UNESCO, 2021). Many countries face the challenge of "brain drain," whereby skilled researchers migrate to systems offering more favorable funding, infrastructure, and career opportunities (UNESCO, 2021). In response, institutions have developed strategies such as international mobility programs, tenure-track systems, and incentives for interdisciplinary collaboration (OECD, 2025).

Within research teams, the clear allocation of roles and responsibilities is essential. Principal investigators typically define strategic directions, while early-career researchers and students often lead data collection and day-to-day analysis. Technical and administrative staff play a crucial role in ensuring operational continuity, compliance with safety and ethical standards, and the efficient functioning of research environments.

I-1-2- Intellectual Conditions

Intellectual conditions refer to the cognitive, educational, and normative environment that shapes how research is conceptualized, conducted, and evaluated. They encompass training and education, access to information, and academic freedom (UNESCO, 2021). High-quality intellectual conditions are essential to ensure that material resources are effectively transformed into meaningful, reliable, and socially relevant knowledge (UNESCO, 2021; UNDESA, 2025).

I-1-2-1- Training and Education

Training and education provide the conceptual and methodological foundation required to conduct research, rather than merely to understand it. At the master's level, education shifts from passive learning to active inquiry, with an emphasis on critical engagement with the literature, the formulation of research questions, and the mastery of research methodologies. This includes both quantitative and qualitative methods, research design, ethics, and academic writing.

Early involvement in research projects, combined with supervision by experienced scholars, is a strong predictor of future scientific productivity (UNESCO, 2021). In many academic systems, students' progress from guided learning activities to independent thesis work, where they are expected to define the scope of their research, justify methodological choices, and manage project timelines. Continuous professional development-through workshops, summer schools, and specialized methodological training-is also essential in a rapidly evolving scientific environment (UNESCO, 2021).

A typical master's curriculum in research methodology integrates the philosophy of science and epistemology, methodological training, discipline-specific seminars, and supervised research projects.

I-1-2-2 - Access to Information

Access to information refers to the ability to consult and utilize the existing body of scientific knowledge that underpins any new research contribution (UNESCO, 2021a; UNESCO, 2023). This includes access to academic journals, databases, e-books, conference proceedings, and data repositories. The expansion of open access publishing and open data initiatives has significantly transformed this landscape by making an increasing proportion of research outputs freely available online (UNESCO, 2021a).

Despite these advances, significant barriers remain - particularly in low-resource institutions that cannot afford comprehensive subscription packages, and in disciplines where leading journals are still restricted by paywalls (UNDESA, 2025). For researchers and master's students, information literacy is therefore as important as access itself. This involves the ability to identify relevant sources, critically evaluate methodological quality, and avoid unreliable or predatory publications.

Effective access to information also depends on the use of appropriate tools, such as academic search platforms, reference management software, and institutional repositories, which facilitate efficient citation practices and the organization of knowledge (UNESCO, 2021a; EUA, 2025).

I-1-2-3 - Academic Freedom

Academic freedom is an essential institutional condition that enables researchers to select their research topics, formulate hypotheses, and disseminate findings without undue interference (UNESCO, 1997, 2024). It is widely regarded as a cornerstone of both scientific advancement and democratic society (UNESCO,2024,2022). International frameworks emphasize that academic freedom safeguards teaching, research, and institutional autonomy from political, economic, and ideological pressures (UNESCO, 1997, 2024).

Restrictions on academic freedom-such as censorship, limitations on sensitive topics, or constraints on publication-can distort research agendas and undermine the credibility of scientific outcomes (UNESCO, 2024, 2022). Conversely, environments that uphold academic freedom tend to promote more innovative, critical, and internationally recognized research (UNESCO, 2024; WIPO, 2025). For individual researchers, an understanding of both the rights

and responsibilities associated with academic freedom is a fundamental component of professional ethics (UNESCO, 1997).

In practice, academic freedom must be balanced with accountability, adherence to ethical standards, and respect for human rights; it serves as a protection for scholarly inquiry, not as a justification for misconduct (UNESCO, 1997, 2024).

II-Ethics and Integrity in Research

II-1- Importance of Scientific Integrity

Scientific integrity constitutes the moral and professional bedrock of the academic enterprise. It refers to the adherence to ethical principles and professional standards that guide the conduct of research from its inception to its dissemination. The importance of scientific integrity can be understood through several dimensions that impact the scientific community and society at large.

First, scientific integrity ensures the reliability and validity of research findings. When researchers operate with integrity, the data they produce and the conclusions they draw can be trusted by other scientists to build further knowledge. Without this trust, the cumulative nature of science would collapse (All European Academies [ALLEA], 2023).

Second, it maintains *public trust in science*. Society provides significant funding and autonomy to research institutions based on the expectation that scientists work for the public good and report their findings honestly. Instances of research misconduct, such as fabrication or falsification, can severely damage this relationship and lead to skepticism regarding scientific expertise in critical areas like medicine or climate change (National Science and Technology Council [NSTC], 2023).

Finally, scientific integrity is essential for accountability and efficiency. It ensures that resources-both financial and human-are used effectively. Research based on fraudulent data leads to wasted efforts by other researchers trying to replicate or build upon non-existent results (Kretser et *al.*, 2019).

"Research integrity is the cornerstone of the scientific method and the basis for public trust in the research community. It is the responsibility of every researcher to uphold these values to ensure the continued progress of human knowledge" (Chenneville, 2026) (Table 2).

Table 2: Impact of Scientific Integrity vs. Research Misconduct

Dimension	**Impact of Integrity**	**Consequences of Misconduct**
Scientific Knowledge	Accelerated progress through reliable data.	Stagnation and wasted resources on false leads.
Public Perception	High trust and support for scientific funding.	Skepticism, loss of funding, and social harm.
Peer Relations	Productive collaboration and mutual respect.	Legal disputes, loss of reputation, and isolation.
Professional Growth	Recognition based on merit and quality.	Career termination and institutional sanctions.

II-2- Fundamental Principles

The practice of research is guided by a set of fundamental principles that define the "Responsible Conduct of Research" (RCR). These principles are not merely abstract ideals but practical requirements for high-quality academic work (Figure 1).

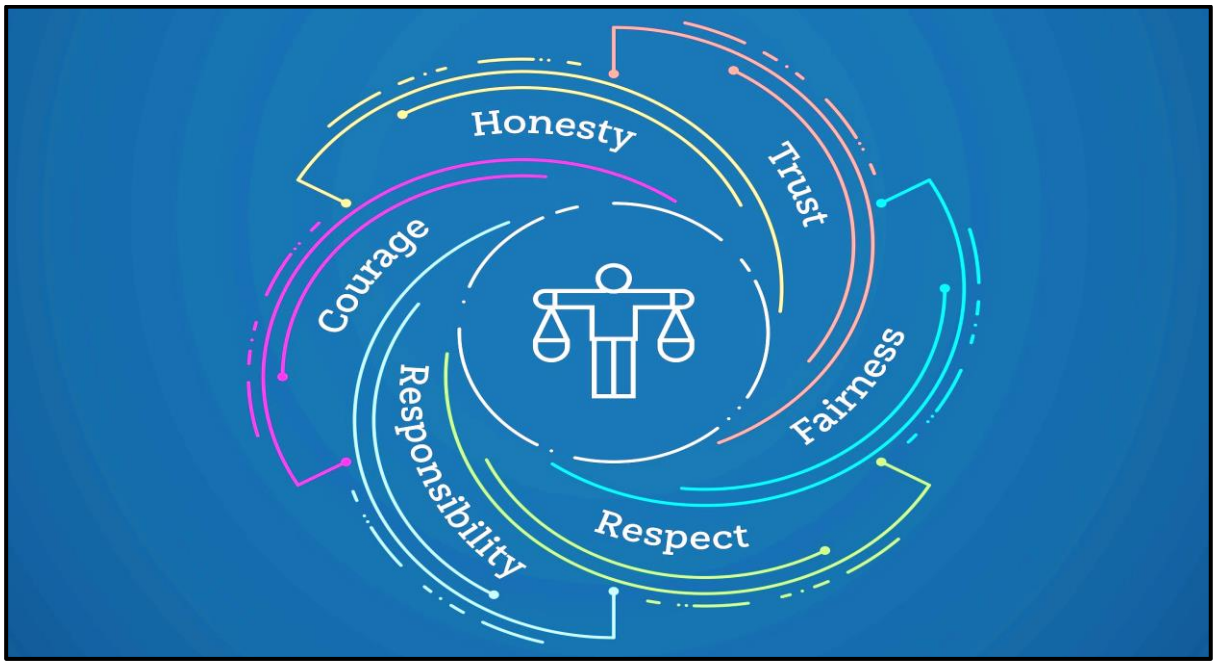

Figure 1: Core components of research integrity (Adapted from UK Research Integrity Office [UKRIO], 2023).

II-2-1- Integrity and Honesty

Integrity and honesty are the most basic requirements for any researcher. Honesty involves being truthful in all aspects of research, including the reporting of methods, data collection, and the presentation of results. Researchers must avoid the "Three Deadly Sins" of research :

- ✓ Fabrication: Making up data or results.
- ✓ Falsification: Manipulating research materials, equipment, or processes, or changing or omitting data.
- ✓ Plagiarism: The appropriation of another person's ideas, processes, results, or words without giving appropriate credit (International Center for Academic Integrity [ICAI], 2021).

Integrity requires consistency between a researcher's actions and the ethical standards of their discipline, even when facing pressure to produce "significant" results or meet tight deadlines (American Psychological Association [APA], 2024).

II-2-2- Academic Freedom

Academic freedom is the principle that researchers should be free to pursue knowledge, teach, and publish their findings without interference or censorship from political, religious, or commercial interests. It is essential for the pursuit of truth, as it allows scientists to challenge prevailing dogmas and explore unpopular or controversial ideas (Scholars at Risk, 2026). However, academic freedom is not absolute; it must be exercised within the framework of ethical responsibility and professional standards.

II-2-3- Responsibility and Competence

Researchers have a responsibility to ensure they possess the necessary competence to conduct their studies. This includes staying updated with the latest methodologies, technologies, and ethical guidelines in their field. Competence also involves the duty of mentors to properly train and supervise junior researchers, ensuring they understand and follow ethical practices (APA, 2024).

Responsibility also extends to the stewardship of resources, the protection of human participants and animal subjects, and the consideration of the environmental impact of research activities (ALLEA, 2023).

II-2-4-Mutual Respect

The scientific community is inherently collaborative. Mutual respect involves acknowledging the contributions of others through proper citation and authorship credit. It also includes conducting fair and unbiased peer reviews and maintaining professional relationships with colleagues, students, and research participants (Kretser et *al.*, 2019). Respect for others' work fosters an environment where ideas can be shared freely and improved through constructive criticism (Figure 2).

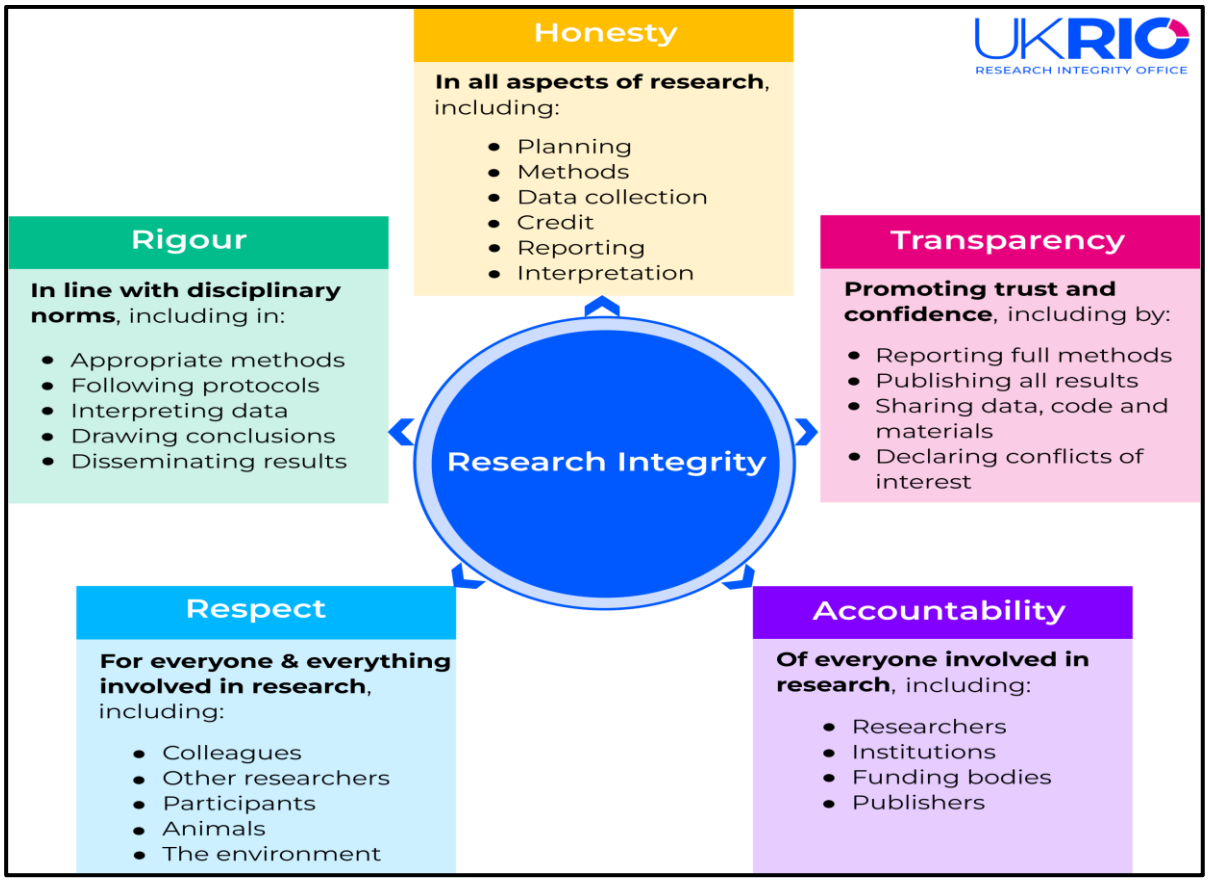

Figure 2: The fundamental values of academic integrity (Source: ICAI, 2021).

II-2-5- Pursuit of Scientific Truth

The primary goal of research is the pursuit of truth through objective and systematic inquiry. This requires researchers to remain open-minded and willing to revise their hypotheses in the light of new evidence. Transparency is key here: by sharing data and methods (Open Science), researchers allow others to verify their work, which is a fundamental mechanism for correcting errors and advancing truth (Chenneville, 2026).

II-2-6- Equity

Equity in research means ensuring fairness and inclusivity. This involves :

- ✓ Fair access to research opportunities and resources for all individuals, regardless of gender, ethnicity, or background.
- ✓ Inclusive research design that considers diverse populations, ensuring that the benefits of science are distributed equitably across society.
- ✓ Diversity in authorship and leadership within research teams to bring varied perspectives to scientific problems (APA, 2024).

II-2-7- Respect for Academic Freedoms

While II-2-2 focuses on the individual right to freedom of inquiry, this principle emphasizes the institutional and collective duty to protect these freedoms. Institutions must create a culture where researchers feel safe to report misconduct without fear of retaliation (whistleblower protection) and where the autonomy of the scientific process is defended against external pressures (Scholars at Risk, 2026).

III- Preparation of Scientific Work and Bibliographic Analysis

Scientific research is a systematic and rigorous process aimed at expanding the boundaries of human knowledge (Al-Riyami, 2024; Creswell et Creswell, 2023). Preparing for such work requires more than curiosity; it demands a structured approach to identifying, analyzing, and synthesizing existing knowledge in order to build a solid foundation for new scientific contributions (McGregor, 2025).

III-1- General Overview and Objectives

The primary objective of this module is to equip master's students with the foundational skills necessary to initiate, design, and plan a scientific research project (Al-Riyami, 2024). Research preparation involves moving from a broad area of interest to a clearly defined and researchable problem through rigorous bibliographic analysis (Zheng et *al.*, 2025).

Objectives

- Systematization: To understand the linear and iterative nature of scientific inquiry.

- Critical literacy: To develop the ability to evaluate the quality, relevance, and reliability of existing literature.
- Methodological rigor: To master the transition from abstract theoretical constructs to empirical investigation.
- Strategic planning: To anticipate the feasibility, outcomes, and potential impact of the proposed research.

As Snyder (2020) notes, "bibliographic analysis is not merely a summary of previous work, but a critical mapping of the intellectual landscape that identifies gaps where new knowledge can be generated."

III-2- Theoretical Concepts

The theoretical phase of research preparation is one of the most critical stages of the research process. It involves the intellectual work of defining what is being studied and clarifying why it is scientifically and socially significant.

III-2-1- Choice of Topic

Selecting a research topic is the first step in the scientific process. For master's students, this decision often requires balancing personal interest with feasibility and academic relevance.

Criteria for Topic Selection (the "FRIENDS" framework) (Table 3)

- ✓ Feasibility: Do you have sufficient time, data, and resources?
- ✓ Relevance**:** Is the topic significant for the field and/or society?
- ✓ Interest: Are you personally motivated to investigate it?
- ✓ Ethics: Can the study be conducted without causing harm? (Smith, 2024).
- ✓ Novelty: Does it offer a new perspective or address an existing gap?
- ✓ Data availability: Is the required information accessible?
- ✓ Scope: Is the topic sufficiently focused and manageable for a master's thesis?

Table 3: Key Criteria for Research Topic Selection and Evaluation

Criterion	**Key Question**
Feasibility	Can this be completed within the 6-12 month timeframe?
Originality	Does this study replicate existing work, or does it extend it?
Academic Value	Will this research contribute to the existing body of theory?

III-2-2- Formulation of a Research Problem

A research problem refers to a specific issue, contradiction, or gap in existing knowledge that a study seeks to address. It constitutes the *raison d'être* of the entire research project.

III-2-2-1- Steps in Problem Formulation

- Identify the broad area**:** e.g., "sustainable urban development."
- Conduct a preliminary literature review: What is already known in the field?
- Identify the gap: What is missing, underexplored, or insufficiently explained? (e.g., a lack of data on small-scale urban gardens).
- Define the problem statement: Formulate a clear and concise description of the research issue to be investigated.

III-2-2-2-The Research Process Flowchart

The conduct of rigorous and methodical research is intrinsically linked to the ability to structure and visualize its progression. A ****Research Process Flowchart****, as depicted in the provided figure, offers a schematic representation of the key stages that guide researchers from initial conceptualization to the formulation of conclusions. This diagram serves as an essential tool for ensuring the coherence, clarity, and logical advancement of any scientific investigation (Mira, 2023) (Figure 3).

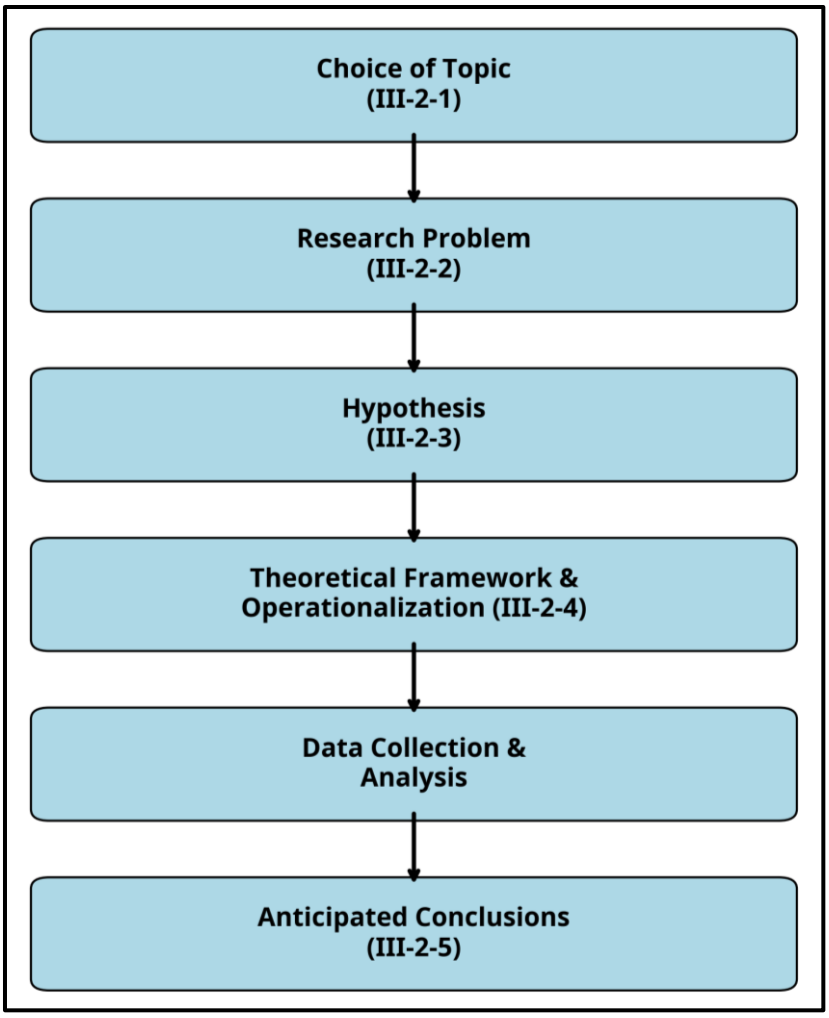

Figure 3: The Scientific Research Preparation Process

III-2-3-Statement of a Hypothesis

A hypothesis is a tentative, testable response to a research question. It is an informed proposition derived from existing theory and preliminary observations (Scribbr, 2025; Kothari, 2004).

III-2-3-1- Characteristics of a Good Hypothesis

A good hypothesis is predictive, as it proposes a relationship between variables (e.g., "If X increases, then Y decreases") (Hulley et *al*., 2013; Akhtar, 2018). It must also be testable, meaning that it can be empirically supported or refuted using data. In addition, it should be clear and simple, avoiding unnecessary jargon and overly complex or multi-layered formulations (Kothari, 2004; Scribbr, 2025).

III-2-3-2 -Types of Hypotheses

The null hypothesis (H_0) states that there is no relationship or effect between the variables (Scribbr, 2025a). In contrast, the alternative hypothesis (H_1) states that a significant relationship or effect exists between the variables (Field, 2013; Scribbr, 2025a).

III-2-4-Operationalization of the Theoretical Framework

Operationalization is the process of defining variables in measurable terms (Rageth, 2021). It involves transforming abstract concepts, such as "student success," into concrete and observable indicators, such as GPA or graduation rate.

III-2-4-1-The Operationalization Chain

The operationalization process follows a structured progression from concept to measurement. It begins with the concept, which represents the abstract idea under investigation, and then moves to its dimensions, which refer to its different aspects or components. These dimensions are translated into indicators, which are the observable manifestations of each dimension, and finally into variables or measures, which correspond to the specific data points collected for analysis (Table 4)**.**

Table 4: Example of Operationalization Process

Concept	Dimension	Indicator	Measure/Variable
Job Satisfaction	Extrinsic Factors	Salary, Benefits	Monthly Income (USD)
Social Capital	Network Density	Number of close friends	Count of contacts
Sustainable Development	Economic Viability	Profitability over 5 years	Net Profit Margin (%)

III-2-5 Statement of Anticipated Conclusions

In the preparation phase, researchers are required to articulate the anticipated conclusions of their study. This does not involve predetermining the results, but rather demonstrating that the research design is coherent and capable of generating meaningful answers (Ross-Hellauer, 2017).

Anticipated conclusions should address several key dimensions: expected findings, based on the hypothesis and existing literature; theoretical contribution, explaining how the study may refine, extend, or challenge current theoretical understanding; practical implications, identifying potential real-world applications or solutions; and limitations, acknowledging the boundaries of the study and what it may not be able to conclude (Tennant et *al*., 2017).

III-3- Applied Concepts

Applied concepts are theoretical principles used to examine and understand empirical data. To be quantifiable in the research context, they must be defined and implemented precisely. These concepts form the basis for understanding the phenomena under study and guide the collection and processing of data (Van Campenhoudt et Quivy, 2011).

III-3-1- Preparation of Empirical Texts (Biological Sciences Perspective)

Empirical texts constitute a fundamental component of scientific writing in the biological sciences, particularly within the *results* section of a thesis, dissertation, or research article. Their primary function is to present data generated through laboratory experimentation, field observation, or computational analysis in a structured, objective, and reproducible manner. A defining feature of empirical writing is the strict separation between the presentation of results and their interpretation, thereby ensuring that findings are reported without bias, speculation, or premature conclusions.

In biological research, empirical texts typically encompass both quantitative and qualitative forms of data. Quantitative data may include measurements such as enzyme activity, gene expression levels, physiological parameters, or growth rates, often accompanied by statistical indicators. Qualitative data, on the other hand, may involve descriptive observations of phenotypic variation, cellular morphology, or behavioral patterns.

The overarching objective of empirical texts is to provide a clear, precise, and verifiable account of experimental outcomes. Such transparency enables independent evaluation, facilitates reproducibility, and supports the cumulative advancement of scientific knowledge.

III-3-1-1- Core Principles of Empirical Text Preparation

The preparation of empirical texts in the biological sciences is governed by rigorous methodological and epistemological standards designed to ensure the reliability, clarity, and scientific validity of reported findings. These principles are essential for maintaining consistency with international norms of scientific writing and for enabling reproducibility and critical evaluation.

III-3-1-1-1- Objectivity

Empirical results must be presented in a strictly objective manner, free from interpretive or speculative language. The results section should describe *what was observed*, not *what it means*. Expressions such as *"this confirms," "this suggests,"* or *"this demonstrates"* should therefore be avoided, as interpretation is reserved for the discussion section.

This distinction between observation and interpretation is widely emphasized in scientific writing guidelines, which stress that results must remain neutral and evidence-based (Day et Gastel, 2022; Glasman-Deal, 2020).

III-3-1-1-2- Accuracy and Precision

Scientific data must be reported with a high degree of accuracy and precision in order to ensure the reliability and scientific validity of the results. This requirement entails the use of appropriate measurement units, preferably following the International System of Units (SI), the correct application of significant figures, and the inclusion of relevant statistical descriptors such as the mean, standard deviation (SD), standard error (SE), or confidence intervals.

For instance, a result may be reported as follows: "Enzyme activity was measured at 45.3 ± 2.1 U/mL (mean ± SD, n = 5)." *Such rigorous reporting practices are essential to ensure that findings are clearly interpretable, methodologically sound, and comparable across different studies, thereby constituting a fundamental component of scientific rigor (Field, 2024; Motulsky, 2023).*

III-3-1-1-3- Clarity and Logical Organization

Empirical data should be presented in a clear, coherent, and logically structured manner to facilitate comprehension and scientific rigor. In biological research, the organization of results typically follows the sequence of research questions or hypotheses, the underlying experimental design, or the specific biological variables under investigation. Such structuring enhances readability and enables readers to follow the progression of the study in a systematic way. Moreover, the strategic use of subsections, tables, and figures plays a crucial role in effectively communicating complex datasets, thereby improving both clarity and interpretability (Cargill et O'Connor, 2021).

III-3-1-1-4- Reproducibility and Transparency

Reproducibility is a cornerstone of scientific research. Empirical texts must provide sufficient detail to allow other researchers to understand precisely what was measured and how the results were obtained.

Although methodological details are primarily presented in the *methods section*, the results must remain consistent with those procedures and clearly reflect the experimental conditions. Transparency in reporting is increasingly emphasized in response to the reproducibility crisis in science (Baker, 2016; National Academies of Sciences, 2019).

III-3-1-1-5- Evidence-Based Reporting

All statements presented in empirical texts must be directly supported by observable or measurable data, ensuring that the results remain strictly evidence-based. Such data may be conveyed through a variety of formats, including tables summarizing numerical results, graphs illustrating trends or relationships, images such as microscopy or electrophoresis gels, and clearly documented raw or processed observations. No claim should be advanced without corresponding empirical support, as this principle guarantees that the results section remains a rigorously data-driven component of the research report. As emphasized in methodological literature, the results section should *"present the evidence in a clear, systematic, and structured manner, enabling readers to assess the validity and reliability of the findings"* (Creswell et Creswell, 2018) (Table 5).

Table 5: Core Principles of Empirical Text Preparation

Principle	Definition	Application in Biological Research
Objectivity	Neutral presentation of results	Avoid interpretive language
Accuracy & Precision	Exact and standardized reporting	Use SI units, statistical indicators
Clarity & Organization	Logical structuring of data	Follow experimental design
Reproducibility	Transparency for replication	Consistent with methods
Evidence-Based Reporting	Data-supported statements	Use tables, figures, images

III-3-1-2- Key Elements with Biology-Specific Examples

III-3-1-2-1- Quantitative Descriptive Summaries

Quantitative data in the biological sciences are typically summarized using both descriptive and inferential statistical methods to ensure accurate interpretation, reproducibility, and scientific validity (Field, 2024; Motulsky, 2023). Descriptive statistics, such as means, standard deviations, and measures of dispersion, provide an overview of data distribution, whereas inferential statistics allow researchers to test hypotheses and determine whether observed differences between experimental conditions are statistically significant (Altman et Bland, 2023; Field, 2024).

For example, in molecular biology, gene expression levels are commonly quantified using quantitative PCR (qPCR), where results can be reported as follows: *"Relative expression levels of the target gene were quantified using qPCR. The treated group exhibited a mean expression level of 2.35 ± 0.42 (fold change), compared to 1.00 ± 0.15 in the control group. Statistical analysis using a Student's t-test revealed a significant difference between groups ($t(18) = 6.12$, $p < 0.001$)."* Similarly, in physiology, enzyme activity data are used to describe functional responses to environmental conditions: *"Enzyme activity increased with temperature up to 37°C, reaching a maximum rate of 85.4 ± 3.2 µmol/min, followed by a decline at higher*

temperatures." Such structured statistical reporting enhances clarity, comparability across studies, and the overall rigor of scientific communication (Pagano et Gauvreau, 2023; Field, 2024).

III-3-1-2-2- Qualitative Observations

Qualitative data play a fundamental role in biological research, particularly in the description and interpretation of structural, morphological, and behavioral phenomena that cannot be fully captured through numerical measurement alone (Creswell et Creswell, 2023; Miles et *al*., 2024). These observations provide rich contextual information that complements quantitative findings and contributes to a more comprehensive understanding of biological systems.

In cell biology, for instance, microscopic analysis may reveal distinct morphological changes under experimental conditions, as illustrated by the following observation: *"Microscopic examination revealed that treated cells exhibited membrane blebbing and nuclear condensation, whereas control cells maintained normal morphology."* In ecological field studies, qualitative observations are equally essential for documenting organismal behavior in natural environments. For example: *"Observed individuals of the species displayed increased foraging activity during early morning hours, with reduced movement during midday heat."* These descriptive records are crucial for identifying biological patterns, generating hypotheses, and supporting the interpretation of experimental or field-based findings within a broader scientific framework (Saldaña, 2021; Miles et *al*., 2024).

III-3-1-2-3 -Verbatim or Observational Records

Although less prevalent than in the social sciences, direct observational records are occasionally employed in biological research, particularly in fields such as behavioral biology and ethnographic ecology (Martin et Bateson, 2021; Lehner, 2023). These records provide valuable, context-specific insights into organismal interactions and natural behaviors that are often difficult to quantify through strictly experimental or laboratory-based approaches. They are particularly useful for capturing spontaneous behavioral patterns in natural or semi-natural environments, thereby enhancing ecological validity and interpretative depth (Sutherland, 2020; Altmann, 2023).

For example, in animal behavior studies, systematic observation can yield precise descriptions of interaction patterns, as illustrated by the following: *"During the observation period, the*

dominant male initiated aggressive interactions in 78% of recorded encounters (n = 45), typically following territorial intrusion." Such observational records contribute to a deeper understanding of social hierarchies, behavioral strategies, and ecological dynamics within species, while also supporting hypothesis generation and comparative behavioral analysis across populations (Martin et Bateson, 2021; Lehner, 2023).

III-3-1-2-4-Tables (Biological Data Presentation)

Tables are essential for organizing numerical data clearly (Table 6)

Table 6 Growth rate of plants under different treatment conditions.

Treatment Group	Mean Growth Rate (cm/day)	Standard Deviation
Control	1.25	0.15
Fertilized	1.78	0.22
Irrigated	1.60	0.18

III-3-1-2-5- Figures and Graphs

Figures and graphs are essential tools in biological research for the effective visualization of data, enabling the clear illustration of trends, patterns, and relationships that may not be immediately apparent in textual or tabular formats. Different types of graphical representations are used depending on the nature of the data and the research objective. For instance, line graphs are commonly employed to depict dynamic processes such as growth curves or enzyme kinetics over time, while bar charts are used to compare values across experimental groups or conditions. Scatter plots, on the other hand, are particularly useful for examining correlations between variables, such as dose–response relationships. A typical example of figure description in biological research may be formulated as follows: *"Figure X illustrates the relationship between substrate concentration and enzyme activity, showing a characteristic Michaelis-*

Menten saturation curve." Such visual representations enhance data interpretation, improve communication of results, and support the overall analytical rigor of scientific reporting.

III-3-1-2-6- Organization of Empirical Results in a Biology Thesis

In biological research, empirical results are typically organized according to a coherent and methodologically justified structure that reflects the logic of the study. This organization may follow the experimental sequence (e.g., Experiment 1, Experiment 2, etc.), the biological hierarchy under investigation (from molecular to cellular, organismal, and ecological levels), or the specific research hypotheses being tested. A standard presentation of results generally includes a brief introductory sentence for each subsection, followed by a clear and systematic presentation of findings integrating both textual descriptions and supporting tables or figures. All visual elements should be explicitly referenced within the text (e.g., *"as shown in Figure 2"*) to guide the reader and ensure coherence. Each subsection should also include a smooth transition to the subsequent set of results in order to maintain logical continuity. Importantly, in accordance with established scientific writing conventions, interpretation and discussion of the findings must be strictly reserved for the discussion section, while the results section remains focused solely on the objective presentation of empirical data.

III-3-1-2-7- Discipline-Specific Good Practices

In biological research, the presentation of empirical data must adhere to a set of discipline-specific good practices that ensure clarity, transparency, and methodological rigor. First, the sample size (n) should always be explicitly reported, as it provides essential context for evaluating the reliability and statistical power of the findings. In addition, statistical significance must be clearly indicated through appropriate measures such as p-values, allowing readers to assess the strength of the observed effects. The consistent use of International System of Units (SI) is also required to maintain standardization and facilitate comparison across studies.

Furthermore, all figures and tables should be accurately labeled and numbered, with descriptive titles that reflect their content. Redundancy between textual descriptions and visual elements should be avoided; instead, the text should highlight key findings while figures and tables present detailed data. Finally, figures must be self-contained, including comprehensive captions that enable readers to understand the content independently of the main text. Collectively, these

practices contribute to the production of high-quality scientific documents that are both accessible and reproducible.

III-3-2- Data Processing

Data processing constitutes a central stage in any research endeavor, involving the systematic organization, analysis, and interpretation of collected data in order to address clearly defined research questions. Its primary objective is to transform raw data-regardless of its form-into meaningful insights, empirically grounded findings, and actionable conclusions. This stage is essential for knowledge production, as it provides the analytical foundation upon which scientific arguments and interpretations are constructed.

III-3-2-1- Overview of Data Processing Approaches

Data processing methods can be broadly classified into three major categories: quantitative**,** qualitative**,** and mixed methods approaches. Each category is characterized by distinct analytical logics, techniques, and tools, selected according to the nature of the data and the objectives of the research.

As noted by Creswell and Creswell (2018), the essence of data processing lies in its capacity to bridge the gap between raw observations and theoretical interpretation. It is at this stage that researchers actively engage with data to identify patterns, test hypotheses, or construct explanatory frameworks.

III-3-2-2- Quantitative Data Processing

Quantitative data processing involves the application of statistical and mathematical techniques to numerical data. This approach is primarily used to test hypotheses, examine relationships between variables, and generalize findings to broader populations. It emphasizes objectivity, precision, and statistical inference.

III-3-2-2-1-Approaches and Techniques

III-3-2-2-1-1-Descriptive and Inferential Statistics in Biological Research

In biological and related empirical sciences, statistical analysis is broadly divided into descriptive and inferential approaches, each serving a distinct methodological function. Descriptive statistics are used to summarize and organize data through measures of frequency

distributions, central tendency (mean, median, and mode), and dispersion (variance and standard deviation), thereby providing a concise overview of dataset characteristics (Field, 2024; Altman et Bland, 2023). In contrast, inferential statistics are employed to draw conclusions about a population based on sample data, allowing researchers to test hypotheses and assess the generalizability of their findings.

Among the most commonly used inferential methods are *t-tests*, which compare the means of two groups; *analysis of variance (ANOVA)*, which evaluates differences among three or more groups; *regression analysis*, which models the relationship between dependent and independent variables (e.g., linear or logistic regression models); and *correlation analysis*, which assesses the strength and direction of relationships between variables, often using Pearson's correlation coefficient (r) (Motulsky, 2023; Field, 2024). For example, a t-test may be used in educational research to compare student performance under two different teaching methods in order to determine whether observed differences in exam scores are statistically significant. Similarly, regression analysis can be applied in economics to examine the relationship between interest rates and consumer spending, enabling the prediction of future behavioral trends. In biomedical research, ANOVA is frequently used to evaluate the effectiveness of multiple drug dosages by comparing mean outcomes across experimental groups.

To perform these analyses, researchers rely on a range of computational tools and statistical software packages, including SPSS, R, Python (with libraries such as NumPy, Pandas, SciPy, and Scikit-learn), SAS, and Stata. These tools facilitate advanced data processing, modeling, and visualization, thereby enhancing the rigor, reproducibility, and analytical depth of scientific research (Kabacoff, 2023; Wickham et *al*., 2023).

III-3-2-2-1-2-Qualitative Data Processing

Qualitative data processing refers to the systematic interpretation of non-numerical data, including textual transcripts, audio recordings, and visual materials, in order to examine meanings, lived experiences, and complex social or behavioral phenomena in depth (Creswell et Poth, 2023; Miles et *al*., 2024). Unlike quantitative approaches, its primary objective is not measurement but the generation of rich, contextualized interpretations that allow researchers to uncover underlying patterns, relationships, and meanings that may not be accessible through statistical analysis alone (Braun et Clarke, 2021; Saldaña, 2021). This process is particularly

important in interdisciplinary fields, including social research and applied biological sciences such as behavioral ecology, where context-dependent phenomena require interpretive depth.

Several analytical approaches are commonly used in qualitative data processing. Thematic analysis involves identifying, analyzing, and interpreting recurring patterns or themes within a dataset (Braun et Clarke, 2021). Content analysis provides a more structured approach by systematically categorizing and, when appropriate, quantifying textual or visual data (Krippendorff, 2019). Coding refers to the process of assigning labels to segments of data in order to organize and interpret meaning systematically (Saldaña, 2021). Narrative analysis focuses on the examination of personal accounts to understand how individuals construct meaning and interpret their experiences over time, while discourse analysis investigates language use in context to reveal how social meanings and power relations are constructed (Gee, 2018; Fairclough, 2019).

For example, in thematic coding, interviews conducted with individuals experiencing homelessness may be analyzed to identify recurring themes such as survival strategies, social exclusion, and coping mechanisms. In content analysis, a researcher might examine media coverage of a political event by analyzing the frequency, tone, and framing of specific terms across different news sources. In narrative analysis, personal journals can be studied to understand psychological processes such as identity formation, trauma recovery, or adaptation to life transitions.

To support qualitative analysis, researchers commonly use specialized software tools such as NVivo, ATLAS.ti, MAXQDA, and Dedoose, which facilitate data organization, coding, retrieval, and thematic mapping, thereby enhancing analytical rigor and transparency (Bazeley et Jackson, 2019; Paulus et *al.*, 2021).

III-3-2-2-1-3- Mixed Methods Data Processing

Mixed methods data processing refers to the systematic integration of quantitative and qualitative data within a single research design in order to provide a more comprehensive and multidimensional understanding of complex research problems (Creswell et Creswell, 2023; Tashakkori et *al.*, 2021). By combining numerical measurement with contextual interpretation, this approach enables researchers to capitalize on the strengths of both paradigms, thereby enhancing explanatory power, validity, and depth of analysis (Plano Clark et Ivankova, 2023).

In this sense, mixed methods research is particularly valuable in interdisciplinary fields where both statistical trends and contextual meanings are essential for interpreting phenomena.

Several integration strategies are commonly used in mixed methods data processing. *Integration* refers to the systematic combination of quantitative and qualitative data at different stages of the research process, including design, analysis, and interpretation. *Quantitizing* involves transforming qualitative data into numerical form for statistical analysis, while *qualitizing* refers to the interpretation of quantitative findings through narrative explanation to provide contextual depth (Sandelowski et *al*., 2019; Fetters et *al*., 2021). *Triangulation* is another key strategy, in which multiple data sources or methods are used to cross-validate findings and enhance the credibility and reliability of results (Denzin, 2017; Creswell et Plano Clark, 2023).

Different methodological designs are commonly employed in mixed methods research. In an *explanatory sequential design*, quantitative data are collected first and subsequently followed by qualitative data to explain or expand on the initial results. In an *exploratory sequential design*, qualitative findings are used as a foundation for developing quantitative instruments or hypotheses. In contrast, a *convergent parallel design* involves the simultaneous collection of quantitative and qualitative data, which are then merged during interpretation to provide a comprehensive analysis of the research problem (Creswell et Plano Clark, 2023; Tashakkori et *al*., 2021).

To implement these approaches, researchers typically use a combination of statistical software (such as SPSS, R, or Stata) and qualitative analysis tools (such as NVivo, ATLAS.ti, or MAXQDA). However, the critical methodological emphasis in mixed methods research lies not only in data analysis but also in the effective integration of findings during interpretation, ensuring coherence and complementarity between quantitative and qualitative results (Plano Clark et Ivankova, 2023).

III-3-2-2-1-4- Comparative Summary of Data Processing Methods

The Table 7 synthesizes the core attributes of quantitative, qualitative, and mixed methods approaches to data analysis.

Table 7 Comparative Summary of Data Processing Methods

Method	**Approach**	**Tools/Techniques**	**Strengths**	**Limitations**
Quantitative	Numerical analysis, hypothesis testing	Statistical modeling, surveys, inferential tests	Objective, generalizable, precise, efficient for large datasets	Limited contextual depth, potential oversimplification
Qualitative	Thematic and interpretive analysis	Coding, interviews, observations	Rich, in-depth insights, exploration of complex phenomena	Subjectivity, limited generalizability, time-intensive
Mixed Methods	Integration of both approaches	Combined analytical tools, triangulation	Comprehensive understanding, increased validity	Methodologically complex, resource-intensive

Data processing is not merely a technical step but a critical intellectual phase in the research process. By selecting appropriate analytical methods and applying them rigorously, researchers can transform raw data into meaningful knowledge, thereby contributing to scientific advancement and informed decision-making.

III-3-3- Construction and Presentation of Bibliographic References

The accurate construction and presentation of bibliographic references constitute a fundamental component of scholarly work. Referencing serves three essential functions: it ensures intellectual integrity by preventing plagiarism, enhances academic credibility by grounding arguments in verifiable sources, and enables readers to efficiently locate and consult the cited materials. Consequently, a well-structured bibliography reflects not only the quality of sources used but also the researcher's methodological rigor and academic discipline.

III-3-3-1-Fundamental Principles and Citation Rules

All bibliographic references are based on four core elements, commonly referred to as the "4 Ws"**:**

- ✓ Author (Who): Identifies the individual(s), group, or institution responsible for the work.
- ✓ Date (When): Indicates the year (and, when relevant, the exact date) of publication.
- ✓ Title (What): Specifies the title of the work, whether a book, article, or digital resource.
- ✓ Source (Where): Provides information on where the work can be accessed (e.g., publisher, journal name, DOI, or URL).

Citation is not merely a technical requirement; it represents a fundamental scholarly practice. As emphasized by Umberto Eco (1977)**,** citing sources involves engaging in an intellectual dialogue with previous research while acknowledging one's academic debt. References must therefore be accurate, verifiable, and coherently integrated into the analytical framework of a thesis or research paper.

III-3-3-2- Comparison of Major Citation Styles (Updated 2024-2026)

The choice of citation style depends largely on disciplinary conventions. The following table summarizes the main characteristics of widely used referencing systems, including recent updates such as the 18th edition of *The Chicago Manual of Style* (2024) (Table 8)**.**

Table 8: Comparative Overview of Major Academic Citation Styles (APA, MLA, and Chicago)

Style	**Primary Discipline**	**In-Text Citation**	**Final List Name**	**Key Features / Recent Updates**
APA (7th ed.)	Social sciences, psychology	(Author, Year)	References	No publisher location; systematic inclusion of DOIs
MLA (9th ed.)	Humanities, arts	(Author Page)	Works Cited	Emphasis on "containers"; simplified URL formatting
Chicago (18th ed.)	History, arts, sciences	Notes–Bibliography or Author–Date	Bibliography	Omission of publisher location; updated author listing rules

III-3-3-3- Technical Details and Illustrative Examples

III-3-3-3-1- APA Style (7th Edition)

APA follows an author–date system and organizes references alphabetically.

In-text citations:

-(Smith, 2023)

-(Jones & Brown, 2022)

-(Garcia et *al*., 2021)

Reference List examples

- **Book**

Smith, J. R. (2023). *The future of digital learning*. Academic Press. https://doi.org/10.1037/0000165-000

- **Journal article**

Jones, A. B., & Brown, C. D. (2022). Impact of AI on research methodologies. *Journal of Advanced Studies, 15*(2), 123–145. https://doi.org/10.xxxx/jas.2022.v15i2.123

- **Website**

Garcia, E. (2021, October 15). Understanding climate change. Environmental Research Institute https://www.eri.org/climate-change

- **AI-generated content**

OpenAI. (2024). *ChatGPT (March 14 version)* [Large language model]. https://chat.openai.com

III-3-3-3-2- MLA Style (9th Edition)

MLA adopts a flexible core elements approach, structured around the concept of "containers."

In-text citations

-(Smith 45)

-(Jones and Brown 123)

-(Garcia)

Works Cited examples:

- Book

Smith, John R. *The Future of Digital Learning*. Academic Press, 2023.

- Journal article:

Jones, Alice B., and Charles D. Brown. "Impact of AI on Research Methodologies." *Journal of Advanced Studies*, vol. 15, no. 2, 2022, pp. 123-45.

- Website

Garcia, Elena. "Understanding Climate Change." Environmental Research Institute, 15 Oct. 2021, www.eri.org/climate-change.

III-3-3-3-3- Chicago Style (18th Edition)

The Chicago Manual of Style (2024) introduces simplifications adapted to digital scholarship. It offers two systems: Notes-Bibliography and Author-Date**.**

✓ **Key updates (18th edition)**

When formatting references, the place of publication is no longer required for books, and self-published works should simply be cited as "published by the author." Furthermore, bibliographies may now list up to six authors for a single work; if a source has more than six contributors, you should list the first three followed by "et *al*."

✓ **Notes-Bibliography examples**

Footnotes

- John R. Smith, *The Future of Digital Learning* (Academic Press, 2023), 45.

-Alice B. Jones and Charles D. Brown, "Impact of AI on Research Methodologies," *Journal of Advanced Studies* 15, no. 2 (2022): 125.

With the growing use of generative AI tools, citation standards have evolved:

-APA Style: AI tools are cited as software (e.g., OpenAI, 2024).

-Chicago Style (18th ed.): AI-generated content is treated as personal communication or generated material, requiring explicit mention of the prompt and date of generation.

For example, a Chicago-style note may state:

Text generated by OpenAI's ChatGPT (March 14 version), using the prompt "Explain the theory of relativity," March 29, 2026.

Mastering bibliographic referencing is essential for academic success. Beyond its technical aspects, proper citation reflects a researcher's ethical responsibility, intellectual rigor, and integration within the scholarly community. As research practices evolve-particularly with digital and AI-generated sources-students and researchers must remain attentive to updated standards and best practices in academic writing.

III-4 -Valorization of Scientific Research

The valorization of scientific research is a key component of national research and technological development strategies, which aim not only to expand knowledge but also to promote scientific, technical, and industrial culture among diverse audiences. This dissemination occurs through multiple channels: within the scientific community through publications, conferences, and symposia; among targeted groups such as students through courses and seminars; and among the general public through outreach activities, exhibitions, and media communication. Such dissemination fosters scientific discussion, stimulates new ideas, and encourages further research, thereby facilitating the circulation and transfer of knowledge (Latour, 1987; Etzkowitz et Leydesdorff, 2000).

In addition, the valorization of research enhances its socio-economic impact by ensuring that scientific results are made useful to society and the economy. It supports innovation, promotes technology transfer through mechanisms such as licensing and patents, and encourages research partnerships with industry for the practical application of scientific findings (Bennai, 2004; OECD, 2002; Chesbrough, 2003; Mowery et Sampat, 2005).

III-4-1- Publications and Dissemination of Research Results

In contemporary academic practice, research is not considered complete until its findings have been effectively and credibly disseminated to appropriate audiences (Hyland, 2015). The primary medium for such dissemination in most disciplines is the peer-reviewed journal article, which ensures rigorous quality control, long-term accessibility, and wide visibility.

This course unit provides a structured overview of the main stages involved in publishing and disseminating research results, with particular attention to current developments in scholarly communication. It addresses key aspects such as scientific publication in peer-reviewed journals and the evolving landscape of peer review (Tennant et *al.*, 2017; Ross-Hellauer, 2017), the strategic selection of appropriate journals for submission, and the process of writing and

submitting a scientific article-particularly through the IMRaD structure and the growing use of AI tools (Day et Gastel, 2012). It also examines the publication process itself, including post-publication dissemination and long-term access to research outputs (Priem et *al*., 2012).

III-4-1-1- Scientific Publication in a Peer-Reviewed Journal

III-4-1-1-1- The role of peer-reviewed journals in scholarly communication

Peer-reviewed journals occupy a central position in the system of scientific communication (Tennant et *al*., 2017). They function as gatekeepers that assess the quality, originality, and relevance of submitted work before it becomes part of the official scientific record (Ross-Hellauer, 2017). This evaluative process ensures that published findings meet minimum standards of methodological soundness, theoretical coherence, and ethical integrity (Smith, 2006).

For early career researchers, publishing in peer-reviewed journals serves several important functions (Hyland, 2015). It validates their research in the eyes of the academic community, ensuring that their work meets established standards of quality and rigor. It also enables them to position their research within existing academic debates, demonstrating how their findings contribute to or challenge current knowledge. In addition, it provides a citable record of scholarly output that can be used in applications for further study, research funding, or academic employment.

Because of this centrality, understanding how peer-reviewed journals and peer review systems operate is a core component of research (Resnik et Shamoo, 2011).

III-4-1-1-2-Principles and Models of Peer Review

Peer review refers to the evaluation of a manuscript by independent experts in the same or a closely related field (Tennant et *al*., 2017). Although procedures vary across journals and disciplines, several principal models are commonly identified in the scholarly literature.

III-4-1-1-2-1-Traditional models of Peer Review

- single-blind peer review, in which reviewers are aware of the authors' identities, while authors do not know the identity of the reviewers (Ross-Hellauer, 2017). This model

remains widely used across many disciplines and continues to serve as the default approach in numerous social science and humanities journals.

- Double-blind peer review is a model in which neither authors nor reviewers are aware of each other's identities (Tennant et *al.*, 2017). This approach is intended to reduce potential biases related to institutional affiliation, nationality, gender, or academic seniority. Meta-analyses suggest that it may mitigate certain forms of bias; however, complete anonymity cannot always be guaranteed, as authorship may sometimes be inferred (Barroga, 2020).

III-4-1-1-2-2- Emerging Models of Peer Review

- In response to the limitations of traditional peer-review systems, several emerging models have been developed to enhance transparency, efficiency, and inclusivity in scholarly evaluation processes. One prominent approach is *open peer review*, which encompasses various forms of transparency, including open identities (where reviewers' names are disclosed), open reports (where review comments are publicly accessible), and open participation (where members of the wider academic community can contribute to the evaluation) (Ross-Hellauer, 2017). While this model has been shown to improve accountability and transparency, it may also discourage reviewer participation due to concerns about visibility and potential professional repercussions (Barroga, 2020).

- Another innovative model is *collaborative and interactive peer review*, which emphasizes a dialogic process involving continuous exchanges between reviewers, editors, and sometimes authors during the evaluation phase. This approach facilitates consensus-building and often results in more constructive, collectively informed revisions that enhance the overall quality of the manuscript (Tennant et *al.*, 2017).

- Additionally, *portable peer review* has emerged as a mechanism to streamline the publication process. In this model, independent organizations conduct standardized pre-submission reviews that authors can submit alongside their manuscripts to multiple journals, thereby reducing redundancy and accelerating editorial decision-making (Barroga, 2020).

- Finally, *post-publication peer review* and commentary-frequently conducted on preprint servers, journal platforms, or academic forums-have become increasingly important

complements to traditional pre-publication review. This approach allows the broader scientific community to engage in ongoing critical evaluation, discussion, and validation of research findings after publication, thereby reinforcing the dynamic and self-correcting nature of scientific knowledge production (Tennant et *al*., 2018).

III-4-1-1-3- Recent Developments and Challenges in Peer Review

- Over the past decade, the peer-review system has encountered significant structural challenges that reflect broader transformations in scholarly publishing (Horta, 2024). One major issue is the substantial increase in manuscript submissions, which has placed considerable pressure on a relatively limited pool of qualified reviewers, resulting in reviewer fatigue and delays in editorial decision-making (Tennant et *al.*, 2017).

- At the same time, the growing complexity of research-particularly in interdisciplinary and data-intensive domains-demands highly specialized and diverse expertise, making it increasingly difficult for editors to identify and coordinate appropriate reviewers (Smith, 2006). Furthermore, the rising emphasis on transparency and reproducibility in science has led to calls for greater openness in peer-review processes, including clearer editorial decisions, increased data accessibility, and, in some cases, disclosure of reviewer identities (Ross-Hellauer, 2017).

- In response to these challenges, publishers and journals have introduced a range of innovations aimed at improving efficiency and maintaining review quality. These include the adoption of AI-assisted tools for preliminary manuscript screening, such as plagiarism detection, reference verification, and identification of potential image manipulation (Mollaki, 2024). In parallel, reviewer databases and algorithmic matching systems have been developed to facilitate the identification of suitable experts and reduce the time required to secure peer reviewers (Tennant et *al*., 2017).

- Additionally, new incentive mechanisms have emerged to recognize reviewers' contributions, including platforms such as Publons (now integrated into Web of Science), formal reviewer certifications, and the inclusion of peer-review activities in academic evaluation systems (Barroga, 2020). Transformative agreements between academic institutions

and publishers have also been introduced to reshape the financial and operational models of scholarly publishing, particularly with respect to publication fees and open-access policies (AME Science, 2025).

- Despite these advancements, important concerns remain. The increasing reliance on automated and algorithmic tools raises questions about potential biases, lack of transparency in decision-making processes, and the consistency and reliability of evaluations. Moreover, there is an ongoing debate regarding the risk of over-dependence on non-human systems at the expense of critical human judgment in scholarly assessment (Mollaki, 2024; Barroga, 2020).

III-4-1-1-4-Ethical Dimensions of Peer Review

- Peer review is not only a technical evaluation process but also an ethical practice governed by a set of fundamental principles that ensure the integrity and reliability of scholarly communication (Smith, 2006; Resnik et Shamoo, 2011). Confidentiality requires that reviewers treat manuscripts as privileged documents and refrain from sharing, discussing, or using unpublished information for personal or professional advantage without explicit authorization from the editorial process (Resnik et Shamoo, 2011).

- Impartiality further demands that reviewers disclose any potential conflicts of interest and decline review assignments when such conflicts may compromise objectivity or fairness in judgment (Smith, 2006). In addition, constructive feedback is essential to the peer-review process; it should be critical yet respectful, aiming to improve the scientific quality, clarity, and rigor of the manuscript while contributing positively to scholarly dialogue (Tennant et *al.*, 2017).

- Finally, timeliness is a key ethical responsibility, requiring reviewers to complete their evaluations within the agreed deadlines in order to support the efficiency and integrity of the publication process (Resnik et Shamoo, 2011).

- Journals often adhere to guidelines established by organizations such as the Committee on Publication Ethics (COPE; https://publicationethics.org) and the International Committee of Medical Journal Editors (ICMJE; https://www.icmje.org). Researchers must be

aware that violations of these standards-such as sharing manuscripts without permission, engaging in unattributed text reuse, or providing biased reviews without declaring conflicts of interest-constitute serious breaches of research integrity (Resnik, 2018).

III-4-1-2- Selection of the Journal for Submission

III-4-1-2-1- Why Journal Selection Is Strategic

- Choosing the appropriate journal is a strategic academic decision that should ideally be made early in the writing process, as it significantly influences the trajectory and success of a research publication (Hyland, 2015). A strong alignment between the manuscript's scope, methodology, and the target journal substantially increases the probability of acceptance, while also ensuring that the research reaches its intended audience, including specialist researchers, practitioners, and policy makers who can directly benefit from the findings (Gasparyan et *al*., 2011).

- Moreover, publishing in a well-matched journal enhances the visibility, discoverability, and potential scholarly impact of the work, contributing to its broader academic and societal influence (Priem et *al*., 2012). In contrast, submitting to an inappropriate or poorly aligned journal often results in *desk rejection*, whereby the manuscript is rejected by the editor without external peer review, leading to unnecessary delays in dissemination and a loss of valuable research time (Hyland, 2015).

III-4-1-2- Selection of the Journal for Submission
III-4-1-2-1- Why Journal Selection Is Strategic

- Choosing an appropriate journal is a strategic decision that should ideally be made early in the writing process (Hyland, 2015). A strong alignment between the manuscript and the target journal can significantly improve publication outcomes.

- It increases the likelihood of acceptance (Hyland, 2015), ensures that the article reaches its intended audience-whether specialists, practitioners, or policymakers (Gasparyan et *al*., 2011), enhances the visibility and overall impact of the research (Priem et *al*., 2012).

- In contrast, submitting to a poorly matched journal often results in desk rejection, meaning that the manuscript is rejected by the editor without being sent for external peer review. This not only delays the publication process but also leads to unnecessary loss of time and effort (Hyland, 2015).

II-4-1-2-2-Core Criteria for Journal Selection

When selecting a journal, authors should systematically evaluate several key criteria, in line with professional guidance provided by research institutions and academic library services (Editage, 2022).

III-4-1-2-2-1- Aims and Scope

The stated aims and scope of the journal, as well as its typical subject areas, must closely align with the content of the manuscript (Hyland, 2015). Authors are advised to review recent issues-particularly those published within the past two to three years-to determine whether similar studies have been accepted and to assess the range and diversity of contributors.

III-4-1-2-2-2-Article Types and Methodological Fit

Journals often prioritize specific types of contributions, such as empirical studies, methodological papers, theoretical analyses, systematic reviews, or qualitative research (Day et Gastel, 2012). They may also favor particular methodological approaches, for example quantitative versus qualitative designs, or experimental versus observational studies. Increasingly, however, many journals explicitly encourage methodological diversity, which is especially relevant for interdisciplinary research (Tennant et *al*., 2017).

III-4-1-2-2-3- Audience and Disciplinary Orientation

Authors should determine whether a journal targets a specialized disciplinary audience, an interdisciplinary readership, or a broader professional community (e.g., practitioners or policymakers) (Gasparyan et *al*., 2011). This consideration directly influences the level of technical detail required, the extent of contextualization, and the way in which the research contribution is framed.

III-4-1-2-2-4- Quality Indicators and Indexing

Although metrics such as the Journal Impact Factor and CiteScore have well-documented limitations (Bornmann et Marx, 2014), they remain widely used as indicators of journal visibility and prestige, particularly in hiring and promotion contexts. More importantly, inclusion in recognized indexing databases (e.g., Web of Science, Scopus, PubMed) enhances the discoverability and citation potential of published articles (Gasparyan et *al*., 2011). For early-career researchers, it is important to note that many disciplinary or regional journals-although not indexed in major databases-play a significant role within their academic communities and may represent more appropriate publication venues than high-impact journals for certain types of research (Tennant et *al*., 2017).

III-4-1-2-2-5- Open Access Model and Costs

Authors must also consider the financial and accessibility aspects of publication. Recent trends indicate that open access has become increasingly widespread, accounting for approximately 47% of all articles published in 2024. The dominant models include Gold Open Access (direct publication in fully open-access journals) and Hybrid Open Access (subscription-based journals offering an open-access option) (Pulse, 2025; AME Science, 2025). Additional factors should also be taken into account, including publication fees, institutional support, and compliance with funder requirements.

- Additional considerations include the level of Article Processing Charges (APCs) and whether these costs are covered by institutional agreements or external funding sources.

- Authors should also consider the availability of Diamond Open Access models, which provide free access to both authors and readers and represent a more equitable-though currently less widespread-segment of scholarly publishing (Pulse, 2025).

- Furthermore, compliance with funder requirements must be taken into account, particularly mandates such as Plan S in Europe, which require that publicly funded research be made openly accessible (Horta, 2024).

III-4-1-2-2-6- Peer Review Model and Timelines

Information regarding the average time to first decision, the type of peer review model employed (e.g., single-blind, double-blind, or open review), and acceptance rates can help authors plan realistic submission timelines and better understand a journal's editorial practices (Hyland, 2015). Many journals now provide such information on their websites or through journal metrics platforms.

III-4-1-2-2-7- Ethical and Transparency Policies

Clear and transparent information on ethical standards, data-sharing requirements, authorship criteria, and the handling of research misconduct is a strong indicator of a credible and reputable journal (Smith, 2006). Authors should also verify whether the journal provides a code of conduct for reviewers, explicit policies on conflicts of interest, and established procedures for handling complaints and disputes (Resnik et Shamoo, 2011).

III-4-1-2-3- Predatory and Low-Quality Journals

A significant concern in the current publishing landscape is the proliferation of so-called predatory or deceptive journals (Beall, 2012). These outlets often imitate legitimate academic journals but typically exhibit several problematic characteristics. They may conduct little or no genuine peer review, maintain unclear, fabricated, or duplicated editorial boards, and aggressively solicit manuscript submissions while offering rapid acceptance in exchange for high publication fees. In addition, such journals often lack proper archiving, indexing, or long-term preservation policies, and may use misleading or confusingly similar titles to reputable journals (Beall, 2012).

Publishing in such outlets can significantly damage a researcher's reputation and diminish the long-term visibility and credibility of their work (Grudniewicz et *al.*, 2019). To avoid these risks, authors should take several precautionary steps.

- They should verify whether the journal is indexed in recognized databases such as Web of Science, Scopus, or PubMed, and carefully examine the credentials and institutional affiliations of editorial board members, ideally through official university websites or ORCID profiles.

- It is also advisable to consult institutional library resources, including curated lists of predatory journals and trusted guidance tools such as *Think. Check. Submit.* or Beall's List (as a historical reference).

- Authors should remain cautious of unsolicited email invitations that promise rapid publication or broad indexing without clear and verifiable evidence (Beall, 2012).

- In addition, they should ensure that the journal provides specific and credible contact information, rather than generic or suspicious details (Grudniewicz et *al.*, 2019).

For early-career researchers, journal selection should ideally be undertaken in consultation with a supervisor and with the support of institutional library services, which often provide training and reliable resources on this issue.

III-4-1-3- Writing and Submission of the Article

III-4-1-3-1- The IMRaD Structure

Most empirical research articles follow the IMRaD structure: Introduction, Methods, Results, and Discussion (Day et Gastel, 2012). This format has become the dominant convention across disciplines because it reflects the logical progression of the research process, facilitates critical reading and evaluation, and allows for systematic comparison between studies (Kumar et Wani, 2024; LinkedIn IMRaD Guide, 2025). Research on academic writing also indicates that students and researchers who effectively apply the IMRaD structure tend to achieve greater clarity, coherence, and higher acceptance rates (Kumar et Wani, 2024).

III-4-1-3-1-1-Introduction

The Introduction situates the study within its broader scholarly context by reviewing relevant literature, identifying a research gap or problem, and clearly stating the research question(s) or hypothesis/hypotheses (Day et Gastel, 2012). It should follow a progression from general to specific, often described as a "funnel structure": beginning with broad background information, narrowing to specific prior studies, highlighting their limitations, and concluding with a concise statement of the study's objectives and expected contributions (Kumar et Wani, 2024).

III-4-1-3-1-2- Methods

The Methods section explains how the study was conducted, providing sufficient detail to allow replication (Day et Gastel, 2012). It typically includes the research design and its justification (e.g., experimental, observational, qualitative; cross-sectional or longitudinal), the sampling strategy or data sources (including population, inclusion and exclusion criteria, and sample size), the instruments or measurement tools used (with attention to validity and reliability), the procedures for data collection (timing and context), and the statistical or analytical methods applied (Kumar et Wani, 2024). Where applicable, ethical approval and informed consent procedures should also be clearly reported.

III-4-1-3-1-3-Results

The Results section presents the main empirical findings of the study, often supported by tables and figures that complement the textual description (Day et Gastel, 2012). Best practice involves organizing the results logically-whether by theme, chronological sequence, or analytical steps and ensuring consistency between the narrative and the data presented in tables and figures (Kumar et Wani, 2024). This section should remain objective and concise, avoiding extensive interpretation or speculation, which is more appropriately addressed in the Discussion section.

III-4-1-3-1-4- Discussion

The Discussion section interprets the results in relation to the research questions, existing literature, and relevant theoretical frameworks (Day et Gastel, 2012). It typically includes an explanation of the main findings and an assessment of whether they support or contradict the initial hypotheses; a comparison of the results with previous studies and their positioning within the broader scholarly context; a critical discussion of the study's limitations and their implications; and suggestions for practical applications as well as directions for future research (Kumar et Wani, 2024).

In many journals, additional components are also required.

- The title should be concise and informative, avoiding acronyms that may not be widely understood.

- A structured abstract (typically 150–250 words) is often organized into sections such as Background or Objectives, Methods, Results, and Conclusions, reflecting the IMRaD structure (Kumar et Wani, 2024).

- Keywords-usually three to six-should be selected from recognized vocabularies such as MeSH (in the health sciences) or other disciplinary thesauri to enhance discoverability.

Acknowledgements are used to recognize contributions from colleagues, funding bodies, or supporting institutions.

- Conflict of interest statements must disclose any financial or institutional relationships that could influence the research (Resnik et Shamoo, 2011).

- A data availability statement should indicate where the underlying data can be accessed or explain any restrictions related to privacy, ethics, or contractual obligations.

- Finally, supplementary materials may include extended methodological details, additional analyses, or supporting data that complement the main article.

III-4-1-3-2 Academic Writing Style

Writing for an academic journal requires a specific style and tone characterized by clarity, precision, coherence, and appropriate rhetorical balance (Hyland, 2015; Day et Gastel, 2012).

- Clarity requires that sentences be straightforward and unambiguous, with complex ideas broken down into manageable components; the passive voice may be used when appropriate, but not at the expense of readability (Hyland, 2015).
- Precision involves the accurate and consistent use of technical terminology, with key concepts clearly defined, particularly upon first mention or when central to the argument (Day et Gastel, 2012).
- Coherence refers to the logical organization of ideas across sentences and paragraphs, supported by effective transitions and metadiscursive markers (e.g., “in contrast,” “however,” “building on this”) that guide the reader through the argument (Hyland, 2004).

- In addition, academic writing requires a balanced use of hedging and assertiveness: authors should avoid overgeneralization or exaggerated claims while still clearly communicating the significance of their findings. Modal verbs such as *may*, might, could, and *should* are commonly used to calibrate the strength of claims (Hyland, 2004).

Researchers must also develop key academic writing skills.

- These include accurate paraphrasing, which involves restating ideas in one's own words while preserving their original meaning and properly citing sources (Resnik, 2018); synthesizing multiple sources by identifying relationships, agreements, and tensions among them rather than merely summarizing (Day et Gastel, 2012); and integrating citations smoothly into the flow of the text, rather than presenting them as isolated references (Hyland, 2015).

- Finally, the consistent use of a recognized referencing style-such as APA (7th edition), Harvard, or Vancouver-is essential for academic credibility and is typically required by the target journal (Day et Gastel, 2012).

Mastery of these conventions is particularly important at the graduate level, as it reflects the researcher's professional competence and scholarly rigor.

III-4-1-3-3-Use and Disclosure of AI Tools in Writing

- With the rapid development of large language models and AI-based writing assistants (e.g., ChatGPT, Claude, Copilot), many authors now use these tools to support language editing, structural organization, idea generation, and code development (AME Science, 2025).

- While such tools can enhance clarity, efficiency, and accessibility-particularly for non-native English speakers-they also raise important concerns regarding authorship, originality, accountability, and research integrity (Mollaki, 2024).

- Emerging best practices, as outlined by major publishers and organizations such as the International Committee of Medical Journal Editors (ICMJE), emphasize several key principles (Mollaki, 2024; AME Science, 2025).

- **AI tools should be used as supportive aids rather than autonomous authors.**

Human authors remain fully responsible for the accuracy, interpretation, originality, and ethical integrity of the content. AI systems cannot assume moral or professional responsibility for published work (Mollaki, 2024).

- **Any substantial use of generative AI**

whether for drafting text, generating images, tables, code, or producing data visualizations- should be clearly and transparently disclosed in the manuscript, typically in the Methods section or Acknowledgements, in accordance with the journal's policies (AME Science, 2025).

- **AI tools cannot be listed as authors**.

Authorship criteria generally require substantial contributions to the conception or design of the study, or to data acquisition and analysis, as well as involvement in drafting or critically revising the manuscript, and accountability for the published work (Mollaki, 2024).

- AI tools must not be used to fabricate, falsify, or manipulate data, references, or citations (Mollaki, 2024). A known limitation of generative AI systems is their tendency to produce plausible but incorrect references ("hallucinations"), which represents a significant concern in academic writing.

- For researchers, supervisors should provide clear guidance on acceptable uses of AI (e.g., grammar checking, paraphrasing support, or outlining) and on prohibited uses (e.g., writing entire sections such as the discussion or generating fabricated citations) (AME Science, 2025). This field is rapidly evolving, and norms continue to develop; therefore, researchers should consult the most recent journal guidelines and funder policies prior to submission.

III-4-1-3-4-The Submission Process

Once the manuscript is complete and an appropriate target journal has been selected, the submission process typically follows several structured steps (Day et Gastel, 2012).

III-4-1-3-4-1-Preparing the Files

Authors must first prepare all required submission materials. This usually includes the main manuscript file, which is often anonymized for double-blind peer review (with author names and identifying information removed from the main text, headers, and footers), as well as separate high-resolution figure files, a cover letter, and any supplementary documents required by the journal (e.g., ethics approval forms, permission letters, or supplementary materials). Some journals may also request a statement of individual author contributions or a "highlights" document summarizing the main findings (Day et Gastel, 2012).

Using the Online Submission System

Most journals use online submission platforms such as Editorial Manager, Scholar One, or Open Journal Systems. Through these systems, authors are typically required to (Tennant et *al*., 2017):

Create an account and complete a detailed author profile.

During the manuscript submission process, authors are required to provide comprehensive and accurate information to facilitate editorial evaluation and peer review. This includes entering essential manuscript metadata, such as the title, abstract, and keywords, which are critical for indexing and discoverability. Authors must also list all co-authors, along with their institutional affiliations and specific contributions to the study, often following standardized frameworks such as the CRediT (Contributor Roles Taxonomy), which promotes transparency and accountability in authorship. In addition, all required files must be uploaded in the formats specified by the journal, typically including the main manuscript document (e.g., .docx or .pdf) and high-resolution figures (e.g., .tif or .jpg). Finally, authors are expected to respond to a series of editorial queries, such as suggesting potential reviewers, declaring any conflicts of interest, and confirming that appropriate ethical approvals have been obtained where necessary (ICMJE, 2023).

III-4-1-3-4-2- The Cover Letter

A concise cover letter (typically no longer than one page) should accompany the submission and clearly present the following elements (Day et Gastel, 2012):

In addition to the manuscript itself, authors are generally required to submit a structured cover letter that clearly articulates the main contribution of the article, emphasizing its originality and scientific novelty, while also justifying its relevance to the journal's scope and intended readership. The letter should include a formal statement confirming that the manuscript is original, has not been previously published, and is not under consideration elsewhere, alongside a declaration of compliance with established ethical standards in research and publication. Furthermore, authors may provide additional contextual information, such as whether the study extends preliminary findings, whether a preprint version has been disseminated, or whether they are eligible for article processing charge waivers due to financial constraints or institutional affiliation in low- and middle-income countries. Such practices contribute to transparency, facilitate editorial assessment, and align with international standards of responsible scholarly publishing (Committee on Publication Ethics [COPE], 2023).

III-4-1-3-4-3-Post-Submission Workflow

After submission, the editor typically conducts an initial screening within one-four weeks. This screening leads to one of two possible outcomes (Tennant et *al.*, 2017):

- **Desk rejection**

The manuscript is rejected without external peer review, most commonly because it falls outside the journal's scope or does not meet its quality standards. In many cases, a desk-rejected manuscript can be submitted to another journal without substantial revision.

- **Sent for peer review**

If the manuscript passes the initial screening, the editor assigns two–four expert reviewers to evaluate the paper. Reviewer selection is increasingly supported by AI-assisted matching systems. This stage of the process typically takes four–twelve weeks, although the exact duration varies depending on the journal and reviewer availability.

III-4-1-3-4-4-The Review Process and Revision

Once reviewers submit their evaluations, the editor makes a decision, typically selecting one of the following outcomes: accept, minor revisions, major revisions, or reject. The decision letter,

together with the reviewers' comments, is then communicated to the authors (Tennant et *al.*, 2017).

If the manuscript is invited for revision, whether minor or major, authors are expected to respond carefully and systematically to each reviewer comment, ensuring that all feedback is thoroughly considered and addressed. This involves revising the manuscript to resolve substantive concerns raised during the review process and improving clarity, accuracy, and overall quality. In addition, authors must prepare a detailed "response to reviewers" document in which each comment is explicitly addressed, indicating the corresponding changes made in the manuscript or, where appropriate, providing a clear and reasoned justification for not implementing a suggested modification. To facilitate efficient re-evaluation by the editor and reviewers, all changes in the revised manuscript should be clearly indicated, typically through the use of the "Track Changes" function in Word or a similar tool.

The response-to-reviewers document is often as important as the revised manuscript itself, as it demonstrates the authors' engagement with peer feedback and their willingness to participate constructively in the review process. In some cases, journals also allow or require a brief rebuttal to specific reviewer comments when authors disagree with particular suggestions.

III-4-1-3-4-5- Acceptance and Production

Once the editor issues an acceptance decision (following any required rounds of revision), the manuscript enters the production phase, which is discussed in Section III-4-1-4.

III-4-1-4- Publication of the Article

III-4-1-4-1- From Acceptance to Publication

After a manuscript is accepted, it moves into the production stage. This phase typically includes the following steps in sequence (Day et Gastel, 2012):

- **Copy editing**

A professional copy editor reviews the manuscript for language accuracy, grammar, stylistic consistency, reference formatting, and adherence to the journal's house style (e.g., spelling conventions, abbreviation usage, punctuation rules).

- **Typesetting and layout**

The article is formatted according to the journal's template using professional publishing software. This includes standardized headings, reference lists, tables, and figures. Page numbers, running headers, and DOI information are also added.

- **Proofreading by authors**

Authors receive proofs (usually in PDF format) to review for typographical errors and minor corrections. At this stage, major content changes are generally discouraged, as they may disrupt the layout and increase production costs.

At the end of this process, the article is assigned to a specific volume and issue of the journal and published online, often in an "online first" or "ahead of print" version, which may appear weeks or months before formal issue publication. Printed versions, where applicable, are released later, depending on the journal's publication format.

III-4-1-4-2- DOI and Metadata

A key element of the publication process is the assignment of a Digital Object Identifier (DOI), which provides a permanent and unique link to a published article https://doi.org/10.1037/a0000000).

Unlike standard URLs, the DOI remains stable even if the journal's website structure or domain name changes, ensuring long-term accessibility and citability of the article (Gasparyan et *al.*, 2011).

In addition, accurate and complete metadata are essential for discoverability, indexing, and proper scholarly attribution (Gasparyan et *al.*, 2011). Key components include:

- **Author names and affiliations**

Variations in name spelling or changes in institutional affiliation can lead to ambiguity and misattribution. To address this issue, many researchers now use ORCID identifiers to ensure consistent author identification across publications (Haak et *al.*, 2012).

- **ORCID identifiers**

These persistent digital identifiers link an author's work across journals, databases, and institutions, which is particularly important for researchers with common names or those who change institutional affiliations over time (Haak et *al.*, 2012).

- **Abstract and keywords**

These elements are indexed by search engines and academic databases and therefore have a direct impact on the visibility of the article. Well-written abstracts and carefully selected keywords significantly enhance discoverability (Gasparyan et *al.*, 2011).

- **Funding information**

Increasingly, funding agencies require that financial support be reported in standardized, machine-readable formats to enable tracking of research outputs and to ensure transparency and accountability (Horta, 2024).

III-4-1-4-3- Post-Publication Dissemination

Publication in a journal does not automatically ensure that an article reaches all its intended or potential audiences. For this reason, authors are encouraged to engage in active post-publication dissemination, which may include the following strategies (Priem et *al.*, 2012; Gasparyan et *al.*, 2014):

III-4-1-4-3-1- Academic Channels

- Depositing the published article or accepted manuscript in institutional or subject-based repositories (e.g., PubMed Central, arXiv, or disciplinary repositories), in accordance with the publisher's embargo periods and copyright policies (Horta, 2024).
- Sharing the article on academic networking platforms such as Research Gate or Academia.edu, while ensuring compliance with copyright and publisher restrictions (Gasparyan et *al.*, 2014).
- Adding the publication to the researcher's ORCID profile and other research information systems to improve visibility, attribution, and integration across scholarly databases (Haak et *al.*, 2012).

III-4-1-4-3-2- Professional Networks and Social Media

After publication, authors are encouraged to actively promote their work to enhance its visibility and impact by announcing it on professional platforms such as LinkedIn, X (formerly Twitter), or discipline-specific social media communities. They should also consider creating a concise "plain language" summary of the article to make the research accessible to a broader, non-academic audience, thereby increasing public engagement and understanding. Additionally, tagging relevant organizations, research groups, or scholars who may have an interest in the topic can help foster academic discussion, encourage knowledge dissemination, and potentially lead to new collaborations or applications of the findings.

III-4-1-4-3-3- Summaries and Outreach Materials

Authors are encouraged to enhance the accessibility and societal impact of their research by preparing plain-language summaries, infographics, or short videos that effectively communicate key findings to non-specialist audiences, including practitioners, patients, policy makers, and the general public (Gasparyan et *al*., 2014). In addition, publishing blog posts or opinion pieces in professional or practitioner-oriented outlets can help contextualize the results, emphasize their practical implications, and bridge the gap between academic research and real-world application. Such dissemination activities can significantly enhance the visibility, uptake, and real-world impact of research, often complementing or even exceeding traditional citation-based indicators (Priem et *al*., 2012).

In this context, Altmetrics-which capture online attention such as social media mentions, news coverage, and policy document citations-have become an important complement to traditional bibliometric measures for assessing research impact (Priem et *al*., 2012).

III-4-1-4-3-4- Long-Term Access and Preservation

Ensuring the long-term accessibility and preservation of research outputs is a central objective of open science and open access policies (AME Science, 2025; Horta, 2024). In practice, long-term preservation relies on several complementary and redundant systems:

- Publisher platforms: The journal publisher maintains the official "version of record" on its website. However, long-term preservation guarantees may be limited and depend on the publisher's policies and infrastructure.

- Institutional repositories: Universities host digital repositories (e.g., DSpace, Fedora) that store preprints, accepted manuscripts, or published versions deposited by authors, ensuring institutional archiving and access.
- Subject repositories: Discipline-specific repositories (e.g., arXiv for physics, PubMed Central for biomedicine, OSF for multidisciplinary research) provide stable and widely accessible platforms for long-term storage and dissemination of research outputs.
- Preservation services: Organizations such as CLOCKSS (Controlled Lots of Copies Keep Stuff Safe) and Portico provide secure archival systems and "dark archives," ensuring that scholarly content remains preserved even if publishers cease operations or journal platforms become unavailable.

For publicly funded research, many funding agencies now require not only open access to publications but also the deposition of underlying research data in trusted repositories, in line with the FAIR principles (Findable, Accessible, Interoperable, Reusable) (Horta, 2024). As a result, researchers are increasingly expected to understand the basics of research data management, including documentation standards, file formats, and metadata practices, as well as the data deposition options available through their institutions (AME Science, 2025).

Publishing and disseminating research findings is an integral component of the scientific process rather than a separate or optional stage (Hyland, 2015). For researchers, developing competence in this area involves:

-Understanding how peer-reviewed journals and peer-review systems operate, including recent developments as well as ongoing challenges (Tennant et *al*., 2017; Horta, 2024).

-Selecting appropriate journals strategically, while also being able to identify predatory or low-quality publishing outlets (Beall, 2012; Grudniewicz et *al*., 2019).

-Mastering the conventions of academic writing, particularly the IMRaD structure, appropriate scholarly style, and the ethical disclosure of AI-assisted writing (Day et Gastel, 2012; Kumar et Wani, 2024; AME Science, 2025).

-Navigating the submission, peer review, and revision processes with professionalism, responsiveness, and flexibility (Hyland, 2015).

-Engaging in responsible, ethical, and open dissemination after publication, including data sharing when appropriate (Priem et *al.*, 2012; Horta, 2024).

These competencies are essential not only for building a successful academic career but also for participating meaningfully and ethically in the ongoing transformation of scholarly communication toward greater transparency, equity, and openness (AME Science, 2025; Horta, 2024).

III-4-2- Institutions Specializing in Research Valorization in Algeria

The valorization of research results is a strategic priority in Algeria, aimed at supporting the transition from a resource-based economy to a knowledge-based economy. This process involves transforming scientific discoveries and technological innovations into economic and social value. In recent years (2020–2026), Algeria has significantly restructured its institutional framework to promote innovation, support startups, and strengthen the link between academia and the industrial sector. This section provides an overview of the main institutions driving this transformation.

III-4-2-1-The Directorate-General for Scientific Research and Technological Development (DGRSDT)

The Directorate-General for Scientific Research and Technological Development (DGRSDT) is the central authority under the Ministry of Higher Education and Scientific Research (MESRS), responsible for defining and implementing national research policy. Its main role in research valorization is to provide the strategic framework and funding mechanisms necessary to support the transition of research outputs toward industrial and applied development (DGRSDT, 2026).

III-4-2-1-1- Key Strategic Roles

The DGRSDT plays a central role in coordinating and steering Algeria's scientific research and technological development activities through three main strategic functions that connect policy-making, funding, and innovation (DGRSDT, 2025):

- Funding and oversight: It manages the National Research Fund and supervises more than 30 national research centers (e.g., CRTI, CDER, CRBT).

- Technological development and innovation support: A dedicated division focuses on innovation management, intellectual property protection, and the promotion of university–industry collaboration.
- Strategic initiatives (2025-2026): Recent priorities have concentrated on key strategic sectors such as food security, water scarcity management, and renewable energy, particularly green hydrogen (DGRSDT, 2025).

III-4-2-2- National Agency for the Valorization of Research Results and Technological Development (ANVREDET) (Figure 4)

Figure 4: Logo of National Agency for the Valorization of Research Results and Technological Development (ANVREDET)

ANVREDET is the main operational agency responsible for the commercialization of research results. It serves as an interface between research laboratories and the economic sector by providing specialized support services to researchers and innovators (ANVREDET, 2024).

Core Services and Performance (2025 Data)

ANVREDET offers a range of services designed to support the transition of research projects from the laboratory to the market. According to its 2025 activity report, the agency has achieved significant progress in supporting and developing innovative projects (Table 9).

Table 9: Overview of Core Services and Performance Indicators (2025 Data)

Service Category	**Description**	**2025 Impact Metrics**
Intellectual Property	Provides guidance and support for patent filing and the protection of innovation rights.	17+ IP experts
Incubation	Offers workspace, mentoring, and networking opportunities for startups.	27+ innovation challenges supported
Project Management	Includes market studies, business modeling, and support for industrial scaling.	88% commercial success rate
Financial Support Linkage	Facilitates connections between projects and funding mechanisms such as the Algerian Startup Fund (ASF).	26+ completed industrial projects

III-4-2-3-The Network of Centers for Technological Support and Innovation (CATI)

The Network of Centers for Technological Support and Innovation (CATI) in Algeria forms part of the World Intellectual Property Organization's (WIPO) Technology and Innovation Support Center (TISC) programme, which aims to provide innovators with access to high-quality, locally based technological information and related support services (WIPO, 2011; WIPO, 2025a).

Within the Algerian context, CATI units are primarily hosted in universities and research institutions and operate in collaboration with national stakeholders, including the Directorate General for Scientific Research and Technological Development (DGRSDT) and the National Institute of Industrial Property (INAPI).

This coordination ensures alignment between intellectual property (IP) information services and national research and innovation policies (WIPO, 2011; WIPO, 2025b).

CATI centers are designed to support researchers, inventors, and entrepreneurs in developing their innovative potential by facilitating access to patent information, strengthening intellectual property management capacities, and fostering linkages between research institutions and the productive sector (WIPO, 2011; WIPO, 2014).

In this regard, CATI plays a crucial intermediary role between the global patent information infrastructure managed by WIPO and the local scientific and innovation ecosystem, which often lacks the specialized expertise and resources required to fully exploit such information (WIPO, 2020; Li, 2020).

III-4-2-3-1- Access to Technical Information

A core function of the CATI network is to provide structured access to technical and patent information through specialized databases and information services (WIPO, 2011; WIPO, 2025a). According to WIPO, Technology and Innovation Support Centers (TISCs) are expected to offer users "access to and assistance in using IP and scientific and technical databases," including national, regional, and international patent collections (WIPO, 2011; WIPO, 2025a). In a university setting, this role involves supporting researchers in navigating platforms such as WIPO's PATENTSCOPE, as well as other scientific and technological databases, in order to retrieve patent documents, scientific literature, and technology trend analyses relevant to their research activities (WIPO, 2011; WIPO, 2020).

Access to high-quality patent information is particularly important for universities and public research institutions, as patent documents often contain detailed technical disclosures that are not available in conventional academic publications (WIPO, 2014). Studies have shown that intellectual property information services within universities can enhance research efficiency by facilitating the identification of existing technological solutions, alternative approaches, and potential collaboration opportunities (Li, 2020; Zhang, 2021). Within the Algerian CATI network, this function is further strengthened by the on-campus presence of CATI units, which reduces access barriers and enables more direct support for students and researchers (WIPO, 2014; WIPO, 2025b).

III-4-2-3-2- Patent Analysis and the "State of the Art"

A second key function of CATI centers is to provide patent search and analytical services, particularly in the form of prior art searches and "state of the art" analyses (WIPO, 2011; WIPO, 2025a). WIPO indicates that TISC services include a wide range of intellectual property search and analytical activities, such as novelty searches, state-of-the-art reports, and technology landscape or trend analyses (WIPO, 2014; WIPO, 2025a). These services enable researchers to assess whether a proposed invention is genuinely novel, to understand its relationship to

existing patented technologies, and to identify potential directions for further innovation and technical improvement (WIPO, 2020).

Within the university context, patent information analysis is increasingly regarded as an essential component of research planning and project evaluation (Li, 2020; Reddy, 2021). By supporting systematic prior art searches, CATI centers help reduce the risk of duplicating existing inventions, guide researchers toward unexplored technological gaps, and provide an evidence base for strategic decisions regarding patent filing or scientific publication (WIPO, 2014; Li, 2020). Furthermore, technology trend analyses conducted through CATI services can inform broader institutional policies, including the prioritization of research funding areas and the development of programs targeting emerging technological domains (WIPO, 2020).

III-4-2-3-3- Training and Awareness in Intellectual Property

A third major function of CATI centers is the provision of training and awareness-raising activities in intellectual property (IP) for students, academic staff, and other stakeholders (WIPO, 2011; WIPO, 2025a). WIPO's guidelines for Technology and Innovation Support Centers (TISCs) emphasize that capacity-building initiatives-such as workshops, seminars, and practical training sessions in patent searching and IP management-are essential to ensure that users can effectively exploit available information resources (WIPO, 2014; WIPO, 2020). In many universities, IP information service units collaborate closely with libraries and technology transfer offices to integrate intellectual property topics into research methodology courses and professional development programs (Li, 2020; Zhang, 2021).

Empirical research on IP information services in higher education indicates that such training activities not only improve awareness of intellectual property rights but also strengthen practical competencies in retrieving, interpreting, and critically analyzing patent literature (Li, 2020; Reddy, 2021). Within the Algerian CATI network, training initiatives are frequently aligned with national or thematic priorities, including sector-specific TISC programs focused on areas such as green technologies. These initiatives help to link intellectual property education with real-world innovation challenges and strategic development objectives (WIPO, 2020; WIPO, 2025b). By developing human capital in the field of intellectual property, CATI contributes to fostering a sustainable, innovation-oriented culture within universities and public research organizations (WIPO, 2011; WIPO, 2014) (Table 10).

Table 10: Main Functions of CATI within the WIPO TISC Framework

Function	**Description**	**Examples in Universities**
Access to technical information	Provision of access to intellectual property (IP) and scientific/technical databases, along with user support and guidance for effective search and retrieval (WIPO, 2011; WIPO, 2025a).	Supervised use of patent databases, helpdesk support for patent searches and scientific information retrieval (WIPO, 2020).
Patent search and analysis	Conducting prior art searches, state-of-the-art analyses, and technology trend or landscape studies to support innovation and research planning (WIPO, 2014; WIPO, 2025a).	Novelty searches for research projects, preparation of technology landscape reports, and patentability assessments (Li, 2020).
Training and IP awareness	Developing competencies in basic IP concepts, patent searching techniques, and intellectual property management (WIPO, 2014; WIPO, 2020).	Workshops, seminars, and integration of IP-related content into academic curricula and research training programs (Li, 2020; Zhang, 2021).

III-4-2-4- University Incubators and the Startup Ecosystem

Since 2020, Algeria has experienced a rapid expansion of university-based support structures aimed at promoting academic entrepreneurship and facilitating the creation of startups emerging from student and faculty research (Brixi et Maliki, 2023; Boudjemaa, 2026). This development reflects a broader policy shift in which universities are no longer perceived solely as institutions dedicated to teaching and knowledge production, but increasingly as active drivers of innovation, enterprise creation, and economic diversification (Etzkowitz et Leydesdorff, 2000; OECD, 2015). Within this framework, university incubators have become a central mechanism for transforming research outputs into viable economic projects and for supporting the transition from academic knowledge to market-oriented innovation (Brixi et Maliki, 2023; University of Algiers 1, 2024).

Academic entrepreneurship refers to the process through which university members create entrepreneurial ventures based on their scientific expertise, technical competencies, or research

outcomes (Etzkowitz et Leydesdorff, 2000; Audretsch, 2014). In the Algerian context, this dynamic has been reinforced by an evolving institutional environment that encourages students and researchers to position themselves not only as learners or scientific authors, but also as potential entrepreneurs, innovators, and project leaders (Brixi et Maliki, 2023; University of Tlemcen, 2026). University incubators play a pivotal role in this ecosystem by providing mentoring, technical assistance, and administrative support necessary to transform early-stage ideas into structured and operational startups (ESAA, 2024; University of Algiers 1, 2024).

III-4-2-4-1- The Labeling System

A distinctive characteristic of the Algerian startup ecosystem is its structured legal and administrative labeling system, which organizes and formalizes support for emerging innovative ventures. This system comprises three main categories: The Startup Label, the Project Label, and the Incubator Label (ASF, 2026; Indjazat, 2023). Collectively, these labels establish a regulated pathway for identifying innovative ideas, validating them institutionally, and connecting them to appropriate financing and support mechanisms (Table 11).

The **Startup Label** is awarded to innovative companies that meet specific eligibility criteria. It grants access to a range of benefits, including tax incentives, official recognition, mentoring services, and specialized funding through the Algerian Startup Fund (ASF, 2026; Indjazat, 2023). According to ASF guidelines, obtaining this label is also a prerequisite for integration into the fund's support programs and broader ecosystem services (ASF, 2026). In this sense, the label functions as a formal validation mechanism, ensuring that a startup is recognized as a legitimate innovation actor before it can benefit from public investment schemes.

The **Project Label** is designed for early-stage initiatives that have not yet reached full startup status but demonstrate clear innovative potential (Indjazat, 2023; Brixi et Maliki, 2023). This label plays a crucial role in providing institutional recognition to emerging ideas and facilitating their progression toward prototyping, validation, and business model development. In practice, it helps prevent promising projects from stagnating or being abandoned due to a lack of early-stage support or visibility.

The **Incubator Label** applies to organizations that provide structured, high-quality support services to project holders and startups (ASF, 2026; ESAA, 2024). Certified incubators are expected to offer mentoring, networking opportunities, administrative guidance, and access to

expert resources. In this regard, the label serves as a quality assurance mechanism, confirming that the incubator meets the required standards to effectively support the development and scaling of innovation projects.

Table 11*:* Labels and functions in the Algerian startup ecosystem

Label / Structure	**Main Purpose**	**Key Benefits / Functions**	**Example in Practice**
Startup Label	Official recognition of an innovative startup (ASF, 2026; Indjazat, 2023).	Provides tax exemptions, access to Algerian Startup Fund (ASF) financing, increased visibility, and mentoring support.	A digital startup obtains the Startup Label and becomes eligible to apply for ASF funding and ecosystem support programs.
Project Label	Recognition of an innovative idea in its early development stage (Indjazat, 2023).	Offers early-stage validation, institutional recognition, and support for prototyping and business model development.	A student-led artificial intelligence project receives Project Label status prior to formal company creation.
Incubator Label	Certification granted to structures that provide high-quality entrepreneurial support services (ASF, 2026).	Includes coaching, networking opportunities, legal and administrative guidance, project follow-up, and access to expert support.	A university incubator supports students in project registration, business plan development, and startup launch processes.

III-4-2-4-2- Role of University Incubators

According to the University of Algiers 1 (2024) and the University of Tlemcen (2026), university incubators in Algeria are now established across a wide range of higher education institutions. Their primary mission is to support innovation-driven entrepreneurship among students and graduates by providing structured assistance throughout the startup creation

process. Their services typically include idea screening, training in business development, support with legal and administrative procedures, access to mentorship networks, and continuous follow-up during the early stages of venture formation (ESAA, 2024; Web3, 2024). These services are particularly important given that many student innovators possess strong technical expertise but often lack experience in business management, legal frameworks, and entrepreneurial strategy.

Empirical research on Algerian incubators indicates that they significantly enhance entrepreneurial intention by fostering a supportive environment and reducing the perceived uncertainty associated with startup creation (ASJP, 2024; Brixi et Maliki, 2023). Moreover, university incubators play a crucial role in bridging academic knowledge and market needs, thereby positioning themselves as strategic instruments for research valorization and local socio-economic development (University of Tlemcen, 2026; OECD, 2015). Their practical impact is particularly evident in sectors such as digital services, healthcare, agriculture, renewable energy, and engineering, where student-led projects can rapidly evolve into viable market-oriented solutions (Algeria Invest, 2025; University of Algiers 1, 2024).

A concrete example is the incubator at the University of Algiers 1, which has actively promoted student project registration, structured mentoring, and commercialization pathways from the ideation phase through to market entry (University of Algiers 1, 2024). Another example is the University of Tlemcen incubator, which was ranked among the leading national incubators in 2025, reflecting the growing institutional maturity of university-based innovation support systems in Algeria (University of Tlemcen, 2026). Overall, these cases illustrate that university incubators are becoming an increasingly central component of Algeria's emerging innovation ecosystem (Figure 6)

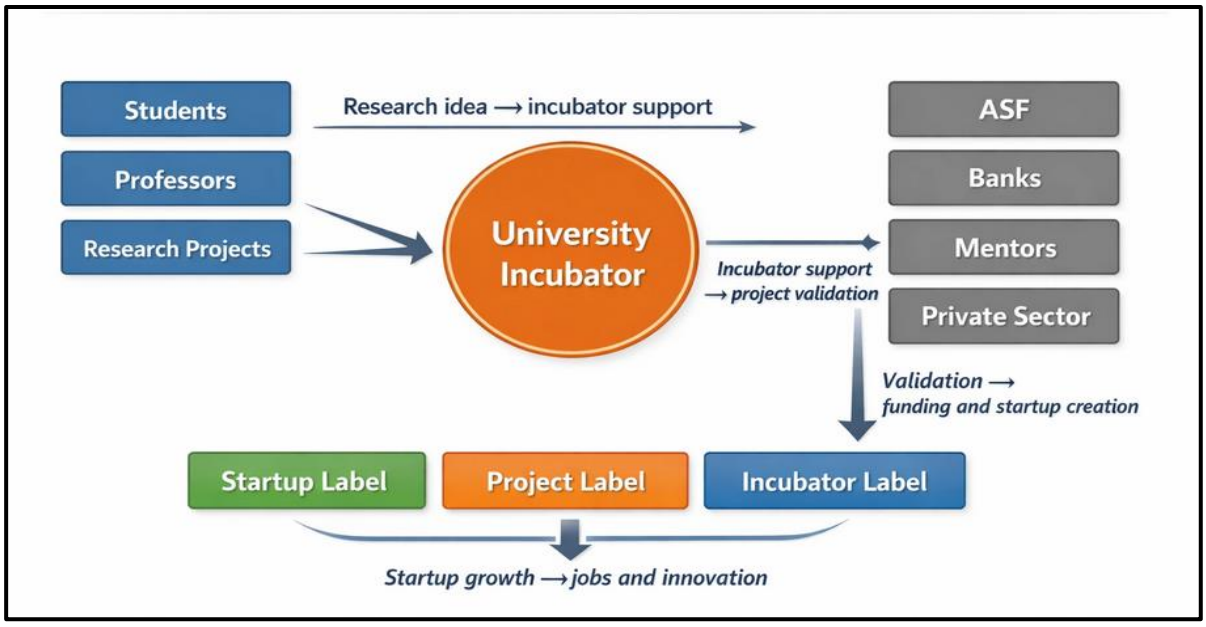

Figure 6: University Incubators and the Startup Ecosystem in Algeria (Etzkowitz et Leydesdorff, 2000; ASF,2026)

III-4-2-4-3- Ecosystem Dynamics

The startup ecosystem does not operate in isolation; rather, it is embedded within a broader network of interconnected public institutions, financing mechanisms, higher education actors, and private-sector partners (ASF, 2026; Brixi et Maliki, 2023). Within this framework, university incubators represent one of the primary entry points into the ecosystem, as they play a key role in identifying early-stage project holders and connecting them to complementary support mechanisms, including startup funding schemes, mentorship networks, and thematic entrepreneurship programs (ASF, 2026; Algeria Invest, 2025). This systemic approach is essential, since the creation of sustainable startups requires not only innovative ideas, but also access to infrastructure, financing, legal recognition, and structured post-incubation support.

Recent indicators suggest that university-based entrepreneurship in Algeria is expanding rapidly, with a growing number of incubators and innovation support centers operating across the national territory (Algeria Invest, 2025; University of Algiers 3, 2026). Current national policies increasingly emphasize not only the creation of innovative projects, but also their contribution to employment generation, regional development, and economic diversification through university-driven innovation (Brixi et Maliki, 2023; University of Algiers 3, 2026). Consequently, university incubators have become strategic actors in Algeria's transition toward a knowledge-based economy (Figure 7).

Figure 7: Algerian Startup Ecosystem Map **(**Arrar et Berkat, 2022)

III-4-2-5- Specialized Research Centers and Valorization Units

Specialized research centers and valorization units play a central role in transforming scientific knowledge into usable technologies, industrial applications, and market-ready products. In Algeria, these institutions function as strategic interfaces between research, innovation, and socio-economic development, particularly in sectors where the country aims to strengthen technological sovereignty and enhance industrial capabilities (CRTI, 2024; CDER, 2024; INRAA, 2026). Their mission extends beyond the production of scientific results to include the transfer of knowledge to industry, the promotion of applied research, and the conversion of research outputs into tangible economic value (Etzkowitz et Leydesdorff, 2000; OECD, 2015).

Unlike general research institutions, specialized centers are structured around clearly defined technical and scientific domains. This thematic specialization enables them to develop high-level expertise, maintain advanced technical infrastructures, and provide tailored services to enterprises and public organizations (CRTI, 2024; WIPO, 2020). In practical terms, they contribute to technology transfer through activities such as prototyping, experimental testing, certification processes, pilot-scale production, technical consultancy, and the valorization of potentially patentable research results (WIPO, 2020; OECD, 2015).

III-4-2-5-1- CRTI: Industrial Technologies and Applied Valorization

The Research Center in Industrial Technologies (CRTI) is one of Algeria's leading institutions in the field of industrial innovation and applied research. According to its official documentation, CRTI specializes in welding technologies, non-destructive testing (NDT), mechanical testing, materials characterization, corrosion studies, metrology, and manufacturing process control (CRTI, 2024). This technical profile positions the center as a key actor in supporting industrial enterprises that require advanced expertise in quality assurance, calibration services, materials analysis, and process optimization.

Beyond its research function, CRTI exemplifies a model of scientific valorization through its extensive portfolio of applied services. Its operational units provide mechanical and chemical testing, welding qualification, NDT calibration, and industrial inspection services, all of which directly respond to the needs of the productive sector (CRTI, 2024). These activities illustrate how a research institution can move beyond a purely publication-oriented mission to become an active operational partner for industry. Within the framework of the triple helix model, CRTI thus operates as an intermediary structure linking universities, government, and industry through knowledge transfer and applied technological services (Etzkowitz et Leydesdorff, 2000).

A concrete example of CRTI's applied impact is its use of non-destructive testing techniques for the evaluation of industrial installations, pipelines, and welded structures. These services contribute to reducing industrial risks, improving quality assurance, and extending the operational lifespan of critical infrastructure. Similarly, CRTI's expertise in welding and metallurgy supports local manufacturing capabilities and helps reduce reliance on external technical assistance (CRTI, 2024). This form of valorization is particularly significant in industrial sectors where safety, precision, and compliance with international standards are essential.

III-4-2-5-2- CDER: Renewable Energy Innovation

The Centre for the Development of Renewable Energies (CDER) is a major Algerian institution engaged in technological development, transfer, and scientific valorization. Its research activities focus primarily on solar energy, wind energy, biomass, and hydrogen-related technologies, all of which are closely aligned with Algeria's national energy transition strategy

(CDER, 2024; Ministry of Finance, Algeria., 2023). In this context, CDER plays a key role in transforming laboratory-based research into applied energy solutions, pilot projects, and policy-relevant technological innovations.

Recent literature highlights Algeria's growing strategic interest in green hydrogen, with CDER identified as one of the principal national research institutions contributing to this emerging field (Ministry of Finance, Algeria., 2023). This area is particularly significant because hydrogen technologies require strong interdisciplinary expertise, combining electrochemistry, energy storage systems, renewable electricity generation, industrial process engineering, and pilot-scale implementation. Consequently, CDER's role extends beyond academic research; it functions as a valorization-oriented institution that supports national energy objectives, environmental transition strategies, and long-term industrial development pathways (Ministry of Finance, Algeria., 2023; OECD, 2015).

A concrete example of CDER's applied contribution is its involvement in pilot initiatives related to green hydrogen production. These projects provide experimental platforms for testing energy conversion technologies, assessing system efficiency, and establishing the foundations for future industrial partnerships. In this sense, CDER operates both as a national laboratory for energy experimentation and as a strategic platform for the future commercialization of renewable energy technologies (Ministry of Finance, Algeria., 2023). Overall, the center illustrates how specialized research institutions can accelerate the transition from scientific knowledge to deployable green technologies.

III-4-2-5-3- INRAA: Agricultural Innovation and Food Sovereignty

The National Institute of Agricultural Research (INRAA) plays a comparable role in the agricultural sector. Its mission is closely linked to agricultural innovation, climate change adaptation, and food sovereignty, which have become increasingly strategic priorities within Algeria's national development framework (INRAA, 2026). INRAA contributes to the advancement of crop improvement, agronomic practices, soil and water management, seed systems, and overall agricultural resilience through applied research and field-based experimentation.

In the context of the 2026 strategic outlook, INRAA's "Horizon 2030" vision places particular emphasis on modernization, digital transformation, and sustainability in agriculture (INRAA,

2026). This orientation reflects a broader international trend in which agricultural research institutions are expected to support national food security objectives through scientific innovation, varietal development, and effective technology transfer to farmers and agribusiness actors (OECD, 2015). In this sense, INRAA's valorization function is not only technological but also socio-economic, as improvements in agricultural research directly contribute to food system stability and rural development.

Concrete examples of INRAA's applied impact include the dissemination of improved crop varieties and optimized cultivation techniques to agricultural producers. Another example is the development of decision-support tools for irrigation planning and soil management. These innovations contribute to reducing agricultural losses, increasing productivity, and enhancing resilience to climate-related stresses. Overall, INRAA demonstrates how specialized research and valorization institutions can simultaneously function as drivers of scientific advancement and as effective instruments for public policy implementation (INRAA, 2026; OECD, 2015).

III-4-2-5-4- Comparative Perspective

Although specialized research centers differ in their thematic focus and scientific domains, they share a common underlying logic based on applied research, technological development, and knowledge transfer. The CRTI is primarily oriented toward industrial competitiveness, the CDER focuses on energy transition and renewable technologies, while INRAA concentrates on agricultural modernization and food sovereignty. Collectively, these institutions constitute a national innovation infrastructure that supports economic diversification and helps reduce the gap between scientific research and industrial application (CRTI, 2024; CDER, 2024; INRAA, 2026) (Table 12 and Figure 8).

Their impact becomes even more significant when their activities are integrated with formal commercialization mechanisms such as patenting, licensing, spin-off creation, and industry partnerships. In this context, valorization units play a crucial role in ensuring that public investments in research translate into tangible economic and social returns (WIPO, 2020; OECD, 2015). For Algeria, the continued strengthening of such institutions represents a strategic step toward an innovation-driven development model and a more diversified knowledge-based economy.

Table 12: Main specialized centers and valorization roles

Center	Main Specialization	Valorization Functions	Practical Examples
CRTI	Industrial technologies, welding, non-destructive testing (NDT), metallurgy, corrosion science (CRTI, 2024).	Materials testing, calibration services, industrial inspection, welding qualification, and materials characterization.	Quality control of industrial installations, pipeline integrity inspection, and technical support for manufacturing industries.
CDER	Renewable energy systems, including solar, wind, and hydrogen technologies (CDER, 2024; Ministry of Finance, Algeria., 2023).	Implementation of pilot projects, applied energy research, technology development, and support for energy transition strategies.	Pilot projects in green hydrogen production, testing of solar energy systems, and validation of renewable energy technologies.
INRAA	Agricultural research, food security, and crop improvement (INRAA, 2026).	Agronomic innovation, field experimentation, technology dissemination, and valorization of seeds and crop varieties.	Development of improved crop varieties, optimization of irrigation systems, and promotion of climate-resilient agricultural practices.

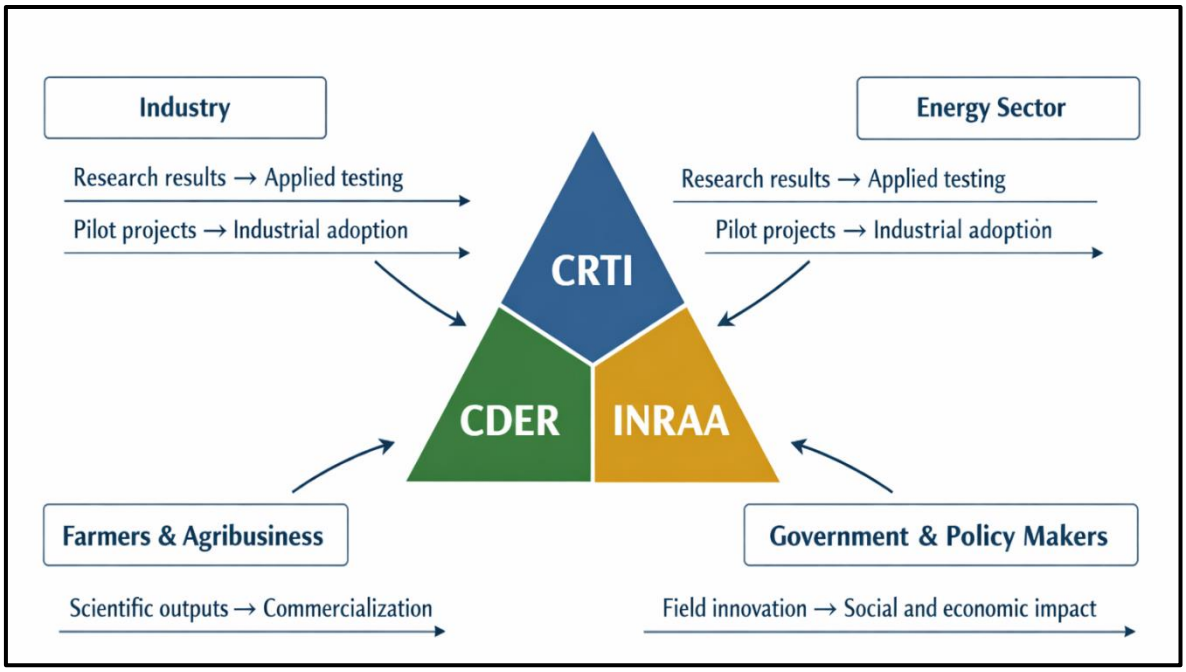

Figure 8*:* Specialized Research Centers and Technology Valorization in Algeria (Etzkowitz et Leydesdorff, 2000, OCDE, 2015).

III-4-2-6 Summary of the Institutional Framework

The following table provides a synthetic overview of the main actors involved in the research valorization chain in Algeria, highlighting their respective roles, target beneficiaries, and expected outcomes (Table 13).

Table 13: Summary of the Institutional Framework

Institution	Primary Focus	Target Audience	Key Outcome
DGRSDT	Policy formulation and research funding	Research centers and universities	Development of strategic national research programs
ANVREDET	Research commercialization	Individual innovators and startups	Transformation of research outputs into market-ready products
CATI	Intellectual property support and information services	Researchers and students	Patent generation and intellectual property protection
ASF	Venture financing and startup support	Labeled startups	Financial scaling and business growth
University Incubators	Early-stage innovation support	Students and academic researchers	Creation and development of new ventures

As illustrated in Figure 9, Algeria achieved notable results during Global Entrepreneurship Week 2025, ranking first worldwide in terms of the number of registered businesses, ahead of countries such as Ethiopia, Brazil, Sri Lanka, and Jordan (Algeria Press Service [APS], 2025). This recognition reflects the growing dynamism of the national entrepreneurial ecosystem, as well as the increasing involvement of universities, incubators, and institutional support structures in fostering entrepreneurship across the country (APS, 2025).

Figure 9: Algeria's Global Recognition in Entrepreneurship

Algeria achieved notable international recognition for its entrepreneurial activity, ranking first globally during Global Entrepreneurship Week 2025 in terms of the number of registered business initiatives (Algeria Press Service [APS], 2025).

The institutional framework for research valorization in Algeria has undergone significant consolidation in recent years. By 2026, the synergy between the Directorate-General for Scientific Research and Technological Development (DGRSDT), the National Agency for the Valorization of Research Results and Technological Development (ANVREDET), and the Algerian Startup Fund (ASF) has contributed to the establishment of a more structured and coherent innovation pipeline. Nevertheless, challenges persist, particularly in strengthening linkages between these institutional actors and the private industrial sector in order to ensure long-term economic sustainability and effective technology transfer.

III-4-3- Scientific Inventors' Patents in Algeria

The contemporary scientific ecosystem in Algeria is no longer confined to the traditional "ivory tower" model of academic research; rather, it is increasingly embedded within a national strategy focused on innovation, economic diversification, and technological sovereignty. In this context, the ability of Algerian researchers to transform laboratory discoveries into legally

protected and potentially marketable intellectual assets is becoming as important as scientific production itself.

This section examines the legal, strategic, and procedural dimensions of patents for scientific inventors in Algeria, with particular reference to Ordinance No. 03-07 on patents and the institutional role of the National Institute of Industrial Property (INAPI).

III-4-3-1- Definition and Objectives of a Patent (Algerian Law)

III-4-3-1-1- Legal Definition and the "Patent Contract"

In Algeria, patents are governed by Ordinance No. 03-07 of 19 July 2003 on patents of invention. According to Article 2, a patent is an official title granted by the National Institute of Industrial Property (INAPI), conferring on its holder the exclusive right to exploit the protected invention. This right establishes a legal monopoly for a period of 20 years from the filing date, subject to the payment of annual maintenance fees (Article 9).

For scientific inventors, the patent can be understood as a form of "social contract" between the inventor and the State. In exchange for a temporary exclusive right of exploitation, the inventor discloses the full technical details of the invention to the public. This legal mechanism ensures both the protection of innovation and the dissemination of scientific knowledge, thereby contributing to the national scientific and technological heritage and enabling further innovation once the patent term expires.

As stated in Article 2 of Ordinance 03-07: *"The patent of invention is a title granted for the protection of an invention."*

III-4-3-1-2- Strategic Objectives for Scientists and Enterprises

Within the Algerian context, the strategic objectives of patenting are closely aligned with national policies aimed at economic diversification, innovation promotion, and the strengthening of technological sovereignty (World Intellectual Property Organization [WIPO], 2023; OECD, 2023). In this framework, intellectual property rights, particularly patents, are considered essential instruments for transforming scientific knowledge into economic and industrial value.

A first major objective is the protection of national research and development (R&D) outputs. Patents play a crucial role in safeguarding innovations generated by Algerian universities and public research institutions such as the *Centre de Recherche en Technologies Industrielles (CRTI)* and the *Centre de Développement des Technologies Avancées (CDTA)*. By securing legal ownership, patents prevent unauthorized exploitation of scientific results and ensure formal recognition of academic and technological contributions (WIPO, 2023).

A second objective concerns economic competitiveness and enterprise development. For Algerian companies, including pharmaceutical industries such as *SAIDAL* as well as emerging technology-based startups, patent protection enhances market positioning, strengthens investor confidence, and increases firm valuation. Empirical studies have shown that strong intellectual property portfolios are positively associated with innovation performance and access to financial capital, particularly in developing economies (OECD, 2023; Hall et Harhoff, 2021).

Finally, patents serve as a key mechanism for technology transfer and innovation diffusion through the so-called incubator and university–industry collaboration models. In this context, patents act as a bridge between academic research and industrial application, facilitating the transformation of laboratory-based discoveries into commercially viable technologies. This process supports an innovation-driven development strategy by promoting knowledge circulation, entrepreneurship, and the creation of technology-based enterprises (Etzkowitz et Zhou, 2018; WIPO, 2023).

III-4-3-1-3- Patentability Criteria in Algerian Law (Article 3)

Under Algerian law, for an invention to be eligible for protection by INAPI, it must satisfy three cumulative criteria. These requirements are presented in Table 14 below.

Table 14: INAPI Patentability Requirements for Scientific Inventions (Article 3)

Criterion	**Algerian Law (Article 3)**	**Scientific Application**
Novelty	The invention must not have been disclosed to the public in any form prior to filing.	Researchers must avoid any prior publication, conference presentation, or public disclosure before submitting the patent application to INAPI.
Inventive Step	The invention must not be obvious to a person skilled in the relevant technical field.	The invention must demonstrate a genuine technical advancement beyond routine modifications or incremental improvements.
Industrial Applicability	The invention must be capable of being manufactured or used in any industrial sector.	Purely theoretical results, abstract ideas, or mathematical formulas are excluded unless they can be translated into practical applications.

The INAPI patent application process transforms a laboratory-based discovery into a legally protected monopoly through a structured sequence of administrative and legal steps grounded in Algerian industrial property law and aligned with international best practices. Each stage-pre-filing, filing, examination, publication, grant, and maintenance-plays a specific role in establishing novelty, priority, and enforceability of the invention (Pila et Torremans, 2019).

III-4-3-2-1- Pre-Filing Stage: Documentation and Prior Art

At the pre-filing stage, the inventor is required to establish a robust evidentiary record supporting the development of the invention. Laboratory notebooks, when properly dated, signed, and continuously maintained, are widely recognized as primary evidence of the conception and technical evolution of an invention (WIPO, 2022). Such documentation can be decisive in resolving priority disputes, particularly in cases where multiple applicants claim similar or overlapping innovations (Pila et Torremans, 2019).

This stage is followed by a systematic prior art search using databases such as the INAPI national repository, Google Patents, and Espacenet. The objective is to evaluate whether the invention satisfies the criteria of novelty and inventive step in light of existing technological disclosures (WIPO, 2022). International patent practice emphasizes that comprehensive prior

art analysis reduces the risk of application refusal, minimizes unnecessary filing costs, and enables applicants to refine claims so as to clearly distinguish their invention from existing technologies (Bently et *al*., 2018).

Importantly, Algerian patent law adopts the universal principle of absolute novelty: any public disclosure prior to filing-whether in a scientific journal, a thesis deposited in an institutional repository, a conference poster, or an oral presentation-results in the loss of novelty and therefore renders the invention non-patentable (INAPI, 2023; WIPO, 2022). This requirement underscores the strategic importance of confidentiality at the early stages of innovation (Table 15).

Table 15: Pre-Filing Stage Activities in the Patent Application Process

Task	**Purpose**	**Typical Tools / Evidence**
Laboratory notebooks	Establish the date of conception and the continuity of the inventive process	Dated and signed entries, witnessed pages, and systematically maintained experimental records
Prior art search	Assess novelty and inventive step in relation to existing technologies	INAPI database, Google Patents, Espacenet, and other scientific and patent literature databases
Confidentialité management	Preserve novelty prior to filing and prevent premature disclosure	Non-Disclosure Agreements (NDAs), restricted access to presentations, reports, and research documentation
Claim drafting strategy	Define the legal scope of protection and differentiate the invention from prior art	Structured patent claims formulated in reference to identified prior art and technical features

III-4-3-2-2- Filing with INAPI (Article 21)

The patent application process within INAPI formally begins with the filing of an application. Under Algerian industrial property law, the application must include a detailed description of the invention, one or more claims defining the scope of protection, any necessary drawings, and

an abstract. These documents are submitted in Arabic, and are frequently accompanied by a French translation to facilitate examination and publication procedures (INAPI, 2023).

The filing date plays a fundamental legal role, as it establishes the priority date. This date is decisive for the assessment of novelty and serves as the reference point against which any subsequent disclosures are evaluated. At this stage, the applicant is also required to pay the prescribed filing fees and receives an official application number, thereby formally entering the national patent system (Pila et Torremans, 2019).

III-4-3-2-3- Formal Examination (Article 27)

After filing, INAPI conducts a formal (administrative) examination of the application. This stage is strictly procedural and is intended to verify compliance with statutory requirements. In particular, INAPI checks that all mandatory documents have been submitted, that the applicable fees have been paid, and that essential formal elements-such as applicant identity, inventor details, and language requirements-are correctly provided (INAPI, 2023).

Importantly, this examination does not address substantive patentability criteria such as novelty, inventive step, or industrial applicability. Its purpose is limited to determining whether the application is admissible and may proceed to publication and subsequent substantive evaluation stages (Bently et *al.*, 2018).

Where deficiencies are identified, INAPI generally issues a formal request for correction within a specified deadline. Failure to remedy these irregularities within the prescribed time frame may result in the application being deemed withdrawn, in accordance with procedural rules governing patent prosecution (WIPO, 2022).

III-4-3-2-4- Publication (Article 30)

Under Article 30, patent applications in Algeria are published 18 months after the filing date or, where applicable, the priority date. This provision aligns with international standards established under the Paris Convention and the Patent Cooperation Treaty (PCT) framework (WIPO, 2022).

Publication in the INAPI official bulletin makes the technical content of the application publicly accessible and contributes to the global corpus of patent literature, which serves as an important

source of technical and scientific information for researchers and innovators (Snyder, 2019) (Table 16).

From the date of publication, the application benefits from provisional protection. This means that, once the patent is granted, the applicant may potentially claim compensation for infringing acts committed after the publication date, subject to the legal conditions governing enforceability and infringement assessment (Pila et Torremans, 2019).

Table 16: Core Legal Milestones in the INAPI Patent Procedure

Stage	Main Legal Basis	Key Legal Effect
Filing	Article 21 (Algerian Intellectual Property Law)	Establishes the filing date and determines the priority date of the invention
Formal examination	Article 27	Verifies compliance with formal requirements, including documentation and payment of fees
Publication (18 months)	Article 30	Makes the application publicly accessible and provides provisional protection
Grant	Article 32	Confers patent rights to the applicant, subject to statutory limitations
Maintenance	Article 51	Requires payment of annual fees to maintain the validity of the patent

III-4-3-2-5- Grant "Without Government Guarantee" (Article 32)

If, following substantive examination, INAPI determines that the application satisfies the patentability requirements of novelty, inventive step, and industrial applicability, it proceeds to grant the patent in accordance with Article 32. Algerian legislation explicitly provides that patents are issued "without guarantee of the State," meaning that the public authority does not guarantee either the validity or the enforceability of the granted patent (INAPI, 2023).

This legal principle is consistent with international patent practice, in which patent office's act as granting authorities but do not assume liability for the legal robustness of granted rights. Consequently, a patent may later be challenged and invalidated in judicial proceedings if previously undiscovered prior art or other legal defects are identified (Bently et *al*., 2018). In

this framework, the responsibility for enforcing patent rights and defending their validity rests entirely with the patent holder (Pila et Torremans, 2019).

III-4-3-2-6- Maintenance and Annual Fees (Article 51)

Once granted, a patent does not confer perpetual protection. Its validity is conditional upon the payment of annual maintenance fees, as stipulated in Article 51 of Algerian patent law. Failure to pay these fees within the prescribed deadlines-subject to a limited grace period-results in the lapse of the patent, after which the invention enters the public domain (WIPO, 2022).

From a policy perspective, the maintenance system serves a dual function. On the one hand, it encourages patent holders to retain protection only for economically or strategically valuable inventions. On the other hand, it facilitates the gradual release of unused or abandoned technologies into the public domain, thereby promoting wider access to knowledge and supporting subsequent innovation (Bently et *al*., 2018).

The diagram below presents the full lifecycle of a patent application within INAPI in Algeria, integrating the relevant legal provisions and academic context (Figure 10). This figure illustrates the procedural progression of a patent from invention disclosure to expiry, in accordance with Ordinance No. 03-07 of 19 July 2003 governing patents in Algeria.

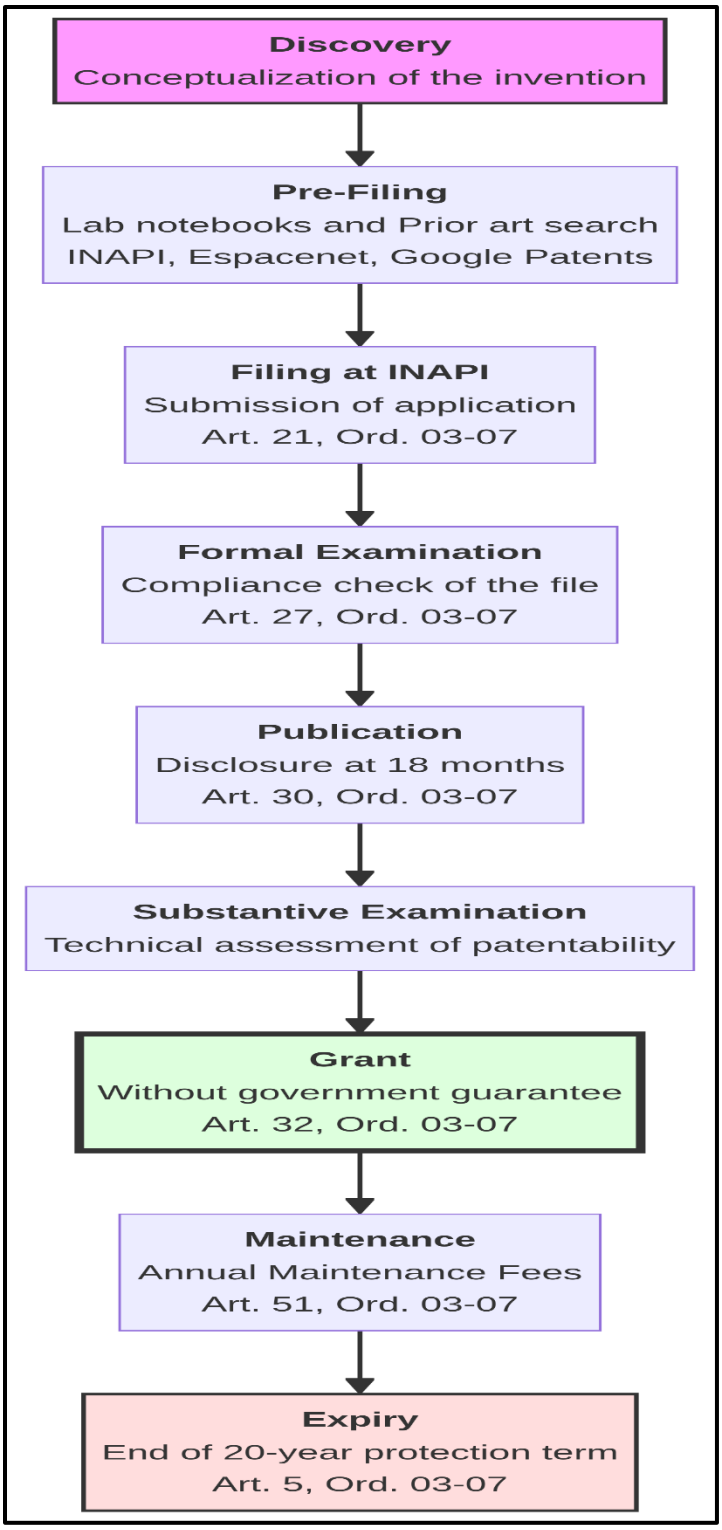

Figure 10 : INAPI Patent Application Life cycle (Ordinance No. 03-07)

III-4-3-3 -Patents in the Enterprise Context (Articles 10 and 11)

The legal relationship between the scientific inventor and the employing enterprise is governed by specific provisions of Algerian patent law, particularly Articles 10 and 11 of Ordinance No. 03-07. These provisions define the conditions of ownership and allocation of rights over inventions created within an employment or institutional context (Table 17).

Table 17: Classification of Inventions and Ownership Rights under Algerian Patent Law (Articles 10 and 11, Ordinance No. 03-07).

Type of Invention	Definition (Articles 10 and 11)	Ownership
Mission invention (Invention de mission)	An invention created within the scope of an employment contract and as part of the inventor's assigned duties.	The employer (enterprise or university)
Non-mission invention using employer resources (Invention hors mission attribuable)	An invention developed outside the inventor's official mission but using resources, data, or support provided by the employer.	The employer, with an obligation to provide fair compensation to the inventor.
Independent invention (Invention indépendante)	An invention developed entirely outside any employment relationship and without the use of employer resources.	The individual inventor

III-4-3-4- Statistical Insights and Trends (2020–2025)

The landscape of scientific patenting in Algeria has been progressively evolving, with a noticeable increase in patent applications originating from universities and public research centers. This development has been particularly supported by the "Un Diplôme, Un Brevet" ("One Degree, One Patent") initiative, which aims to encourage academic inventors to translate their research outputs into protected intellectual property (Figures 11 and 12).

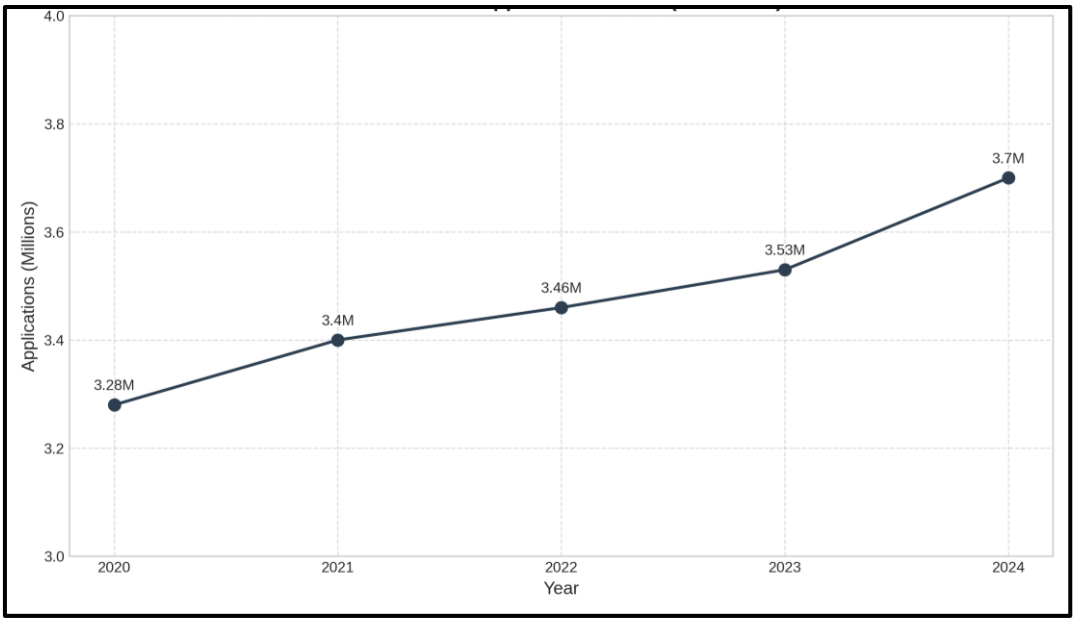

Figure 11 : Global Patent Application Trends (2020-2024)

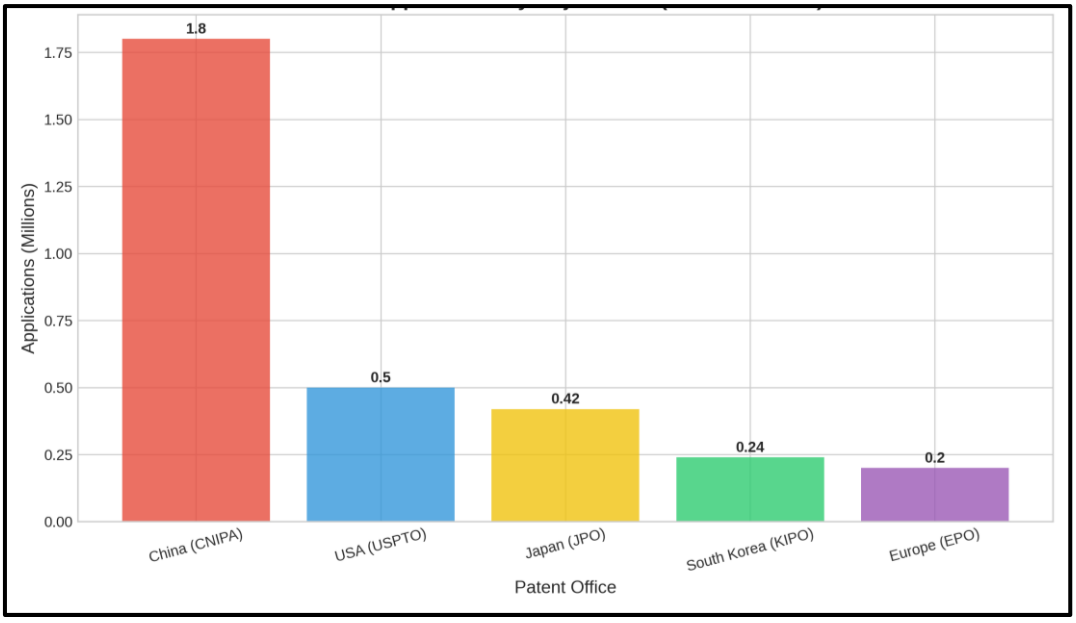

Figure 12: Patent Applications by Major Offices (2024 Estimates)

III-4-4- Business Creation

Entrepreneurship as a National Priority

In the current economic context, Algeria is undergoing a gradual transition from a hydrocarbon-dependent model toward a more diversified, knowledge-based economy. Within this transformation, entrepreneurship has emerged as a central strategic priority, supported by

national policy frameworks such as “Un Diplôme, Une Startup” (Ministerial Order No. 1275). For scientific inventors and graduate students, understanding the mechanisms of business creation represents a crucial step in translating academic research into sustainable economic value.

III-4-4-1- Steps in Business Creation (Algerian Context)

III-4-4-1-1- Ideation and Market Validation

The initial stage of business creation consists of identifying and structuring a viable market opportunity within the Algerian economic context, where innovation-driven sectors such as agritech, fintech, and renewable energy are increasingly recognized as strategic areas for growth and diversification (World Bank, 2024; OECD, 2023). This phase is critical, as it determines the alignment between an entrepreneurial idea and real market needs, as well as its potential for scalability and sustainability in a competitive environment.

At this stage, university-based incubators play a fundamental role in supporting students, researchers, and early-stage entrepreneurs by facilitating idea validation, market need assessment, and the development of a Minimum Viable Product (MVP). Through mentorship, technical guidance, and access to entrepreneurial ecosystems, these structures help reduce the high level of uncertainty associated with early innovation processes and improve the probability of project success (Autio et *al.*, 2018; Cavallo et *al.*, 2019). Furthermore, MVP development is widely recognized in entrepreneurship literature as a key mechanism for testing assumptions, gathering user feedback, and iteratively refining product–market fit before large-scale investment is undertaken (Ries, 2011; Blank, 2020) (Table 18).

Table 18: Overview of Key Legal Forms for Businesses in Algeria

Legal Form	**Key Characteristics**	**Target Audience**
SARL / EURL	Limited liability structure with a minimum capital requirement of 100,000 DZD.	Small and medium-sized enterprises (SMEs) and individual entrepreneurs.
SPA	Public limited company requiring a minimum capital of 1,000,000 DZD and at least seven shareholders.	Large-scale industrial and corporate projects.
SNC	General partnership characterized by unlimited liability for partners.	Family-owned businesses and small partnership-based enterprises.

III-4-4-1-2- Legal and Administrative Procedures (CNRC)

The formal establishment of a business in Algeria is governed by a structured administrative framework, primarily overseen by the *Centre National du Registre du Commerce (CNRC)*, which is responsible for the legal registration, identification, and recognition of economic activities at the national level (CNRC, 2023; World Bank, 2024). This institutional process ensures that entrepreneurial ventures operate within a regulated legal environment, thereby facilitating compliance with national commercial and fiscal regulations.

In this context, Table 18 summarizes the main legal forms available to entrepreneurs in Algeria, highlighting their respective capital requirements, liability regimes, and target entrepreneurial profiles. Such classification is essential for understanding the institutional pathways available for business formalization and for selecting an appropriate legal structure aligned with the nature and scale of the project.

III-4-4-1-3- The Registration Roadmap

The business registration process in Algeria follows a structured multi-step procedure administered primarily by the *Centre National du Registre du Commerce (CNRC)*. This

institutional framework is designed to ensure legal compliance, administrative transparency, and operational readiness for newly created enterprises, thereby formalizing economic activity within the national regulatory system (CNRC, 2023; World Bank, 2024). The registration sequence typically includes several key stages: name reservation, drafting of company statutes, capital deposit, issuance of the commercial register, followed by fiscal and social registration. Together, these steps constitute the legal foundation for business incorporation and formal market entry.

In recent years, the Algerian administration has progressively introduced digitalization measures aimed at improving efficiency and reducing bureaucratic delays. In this context, the *"Sidjilcom"* electronic platform has been implemented to facilitate certain registration procedures, allowing entrepreneurs to complete several steps online and thereby minimizing processing time and administrative burden. Such digital transformation initiatives are consistent with broader public-sector modernization strategies aimed at enhancing ease of doing business and improving institutional efficiency in emerging economies (OECD, 2023; World Bank, 2024) (Table 19).

III-4-4-1-3-1- Business Name Reservation (Denomination)

The first step consists of securing a unique business name at the CNRC. Applicants may propose up to four name options through an official application form and are required to pay a search fee through the National Bank of Algeria (BNA). If the proposed name is approved, a certificate of name reservation is issued, typically valid for six months. This procedure ensures the uniqueness of the commercial identity and prevents conflicts between enterprises. The increasing use of electronic processing has significantly improved response times and administrative efficiency. From an institutional perspective, this step contributes to the establishment of commercial trust through formal public registration systems (Hennane, 2024).

III-4-4-1-3-2- Drafting of Statutes

The second stage involves the drafting of the company's statutes (articles of association), which must be prepared and authenticated by a public notary. This process requires supporting legal documents, including identification papers of partners, birth certificates, lease agreements, and auditor commitments where applicable. The statutes must clearly define the company's legal form, corporate purpose, capital structure, and governance arrangements. Following

notarization, the statutes are published in the Official Bulletin of Legal Announcements (BOAL), with associated publication costs (approximately 7,000 DZD). Algerian law requires notarization for legal validity, ensuring both legal certainty and fiscal compliance (Hennane, 2024).

III-4-4-1-3-3- Capital Deposit

Prior to final registration, the initial share capital must be deposited into a bank account. The financial institution issues a certificate of deposit, which is required for the finalization of the statutes. Minimum capital requirements vary depending on the legal form of the company (for example, 100,000 DZD for a SARL). This requirement serves as proof of financial commitment by the founders and provides a basic safeguard for creditors (World Bank, 2010).

III-4-4-1-3-4- Commercial Registration

The final submission to the CNRC results in the issuance of the Commercial Register (Registre de Commerce, RC), which includes a unique identification number (NIS). This stage requires payment of applicable fees (including stamp duties, approximately 4,000 DZD) and verification of submitted documents. Online platforms such as CNRC Info now allow for partial or full electronic submission, in accordance with Law 04-08, which requires registration within two months of business creation. The RC constitutes the official legal recognition of the enterprise and serves as a central reference within the national business registry system (Belguendouz, 2017).

III-4-4-1-3 -5- Fiscal and Social Registration

After obtaining the Commercial Register, enterprises must complete fiscal and social formalities. This includes obtaining a Tax Identification Number (NIF) from the tax authorities and registering with the relevant social security institutions-CASNOS for self-employed individuals or CNAS for salaried employees. Required documents typically include a copy of the RC and completed registration forms, with processing times averaging approximately four days. Where applicable, Value Added Tax (VAT) registration is also required. Social security contributions generally represent around 15% of the salary base. These procedures ensure full compliance with national fiscal and social protection systems (Derbal et Sayah, 2024).

Table 19: Business Registration Process in Algeria - Key Steps, Requirements, and Timelines

Step	Key Actions	Required Documents / Fees	Typical Timeframe
Name reservation (Denomination)	Submission of up to four proposed business names to the CNRC for availability verification	Copy of identification document; payment of name search fee	Same day (subject to availability)
Drafting of Statutes	Preparation and notarization of the articles of association; publication in the Official Bulletin of Legal Announcements (BOAL)	Identification documents, lease agreement, notarized statutes; publication fee (approximately 7,000 DZD)	One to two weeks
Capital deposit	Deposit of initial share capital in a bank account and issuance of a deposit certificate	Proof of minimum capital deposit, depending on legal form	one day
Commercial registration	Submission of application file to CNRC and issuance of the Commercial Register (RC) and NIS number	Notarized statutes, administrative forms, payment of registration fees (including stamp duty of approximately 4,000 DZD)	one to two days.
Fiscal and social registration	Registration with tax authorities (NIF) and social security bodies (CASNOS or CNAS)	Copy of Commercial Register (RC), completed administrative forms; social contributions (approximately 15% of salary base)	Approximately four days

III-4-4-1-4- Specialized Labeling (startup.dz)

Innovative projects in Algeria may apply for the **"Startup Label"** through the national digital platform *startup.dz*. This official designation constitutes a key instrument within the national entrepreneurship policy framework, as it formally recognizes the innovative character of a venture and facilitates its integration into the institutional support ecosystem.

The Startup Label provides several strategic advantages, including significant tax incentives-such as exemptions from Corporate Income Tax (IBS), the Professional Activity Tax (TAP), and Value Added Tax (VAT)-as well as preferential access to equity-based financing through the Algerian Startup Fund (ASF). More broadly, the label enhances the visibility, credibility, and legitimacy of early-stage ventures, thereby improving their ability to attract partners, investors, and institutional support.

III-4-4-2- Challenges in Business Creation

III-4-4-2-1- Regulatory and Financial Barriers

Despite ongoing efforts toward administrative digitalization and regulatory modernization, bureaucratic complexity remains a significant constraint on business creation in Algeria (OECD, 2023; World Bank, 2024). Entrepreneurs frequently encounter procedural delays in obtaining licenses, permits, and regulatory authorizations, in addition to challenges associated with navigating evolving tax frameworks and legal compliance requirements. These administrative inefficiencies can increase transaction costs and delay market entry, thereby affecting overall entrepreneurial performance.

Furthermore, access to traditional bank financing remains limited, particularly for early-stage ventures and innovative startups. Financial institutions often require substantial collateral and strict credit guarantees, which many young entrepreneurs and recent graduates are unable to provide. This structural constraint has been widely identified in development literature as a key barrier to entrepreneurial entry and innovation diffusion in emerging economies (Beck et Demirgüç-Kunt, 2021; OECD, 2023). As a result, limited access to credit significantly restricts the scalability and sustainability of innovative projects, particularly in knowledge-intensive sectors.

III-4-4-2-2- Market and Operational Challenges

Beyond regulatory and financial constraints, startups in Algeria face a set of structural market and operational challenges that significantly affect their competitiveness and long-term sustainability. One of the most prominent issues is competition from the informal sector, which can distort market dynamics by introducing unfair pricing mechanisms, reducing tax compliance, and creating regulatory asymmetries that disadvantage formally registered enterprises (OECD, 2023; World Bank, 2024). This dual economic structure often undermines fair competition and limits the capacity of startups to scale within a fully regulated environment.

In addition, restrictions related to international payment systems represent a significant operational barrier for startups, particularly those operating in digital and technology-driven sectors. Limited access to global financial infrastructure can hinder the use of essential services such as cloud computing platforms, digital marketing tools, and international online payment gateways, thereby constraining integration into global digital value chains (UNCTAD, 2023). These limitations reduce the international competitiveness of Algerian startups and restrict their ability to expand beyond domestic markets.

Another persistent structural challenge is the phenomenon of brain drain, characterized by the emigration of highly skilled professionals, particularly in engineering, information technology, and digital innovation fields. This trend reduces the availability of qualified human capital within the national ecosystem and complicates recruitment and talent retention strategies for startups. As a result, firms often face difficulties in building specialized teams capable of supporting innovation, growth, and internationalization processes (World Bank, 2024; OECD, 2023). This dynamic is illustrated in Figure 13, which highlights the impact of skilled migration on the development trajectory of entrepreneurial ventures.

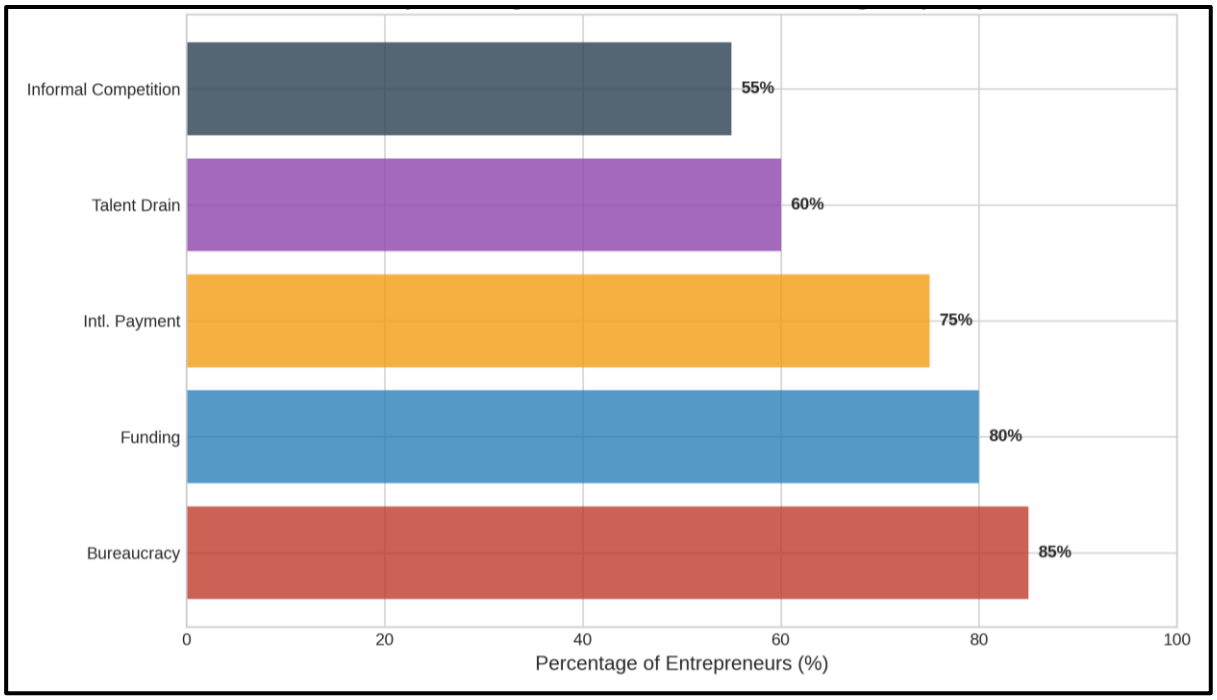

Figure 13: Major Challenges for Business Creation in Algeria (2024)

III-4-4-3- Tools for Successful Business Creation

Public support mechanisms play a critical role in mitigating the financial, administrative, and structural barriers faced by entrepreneurs in Algeria, particularly those involved in micro-enterprises and innovation-driven startups (ANADE, 2024; ASF, 2026; AAPI, 2025). These instruments operate in a complementary manner, addressing different phases and scales of business development-from small, locally embedded projects to large-scale investment initiatives (PwC, 2025).

III-4-4-3-1- Public Support Mechanisms

- ***ANADE (formerly ANSEJ)***

The National Agency for Entrepreneurship Support and Development (ANADE) is a key public institution targeting young entrepreneurs and micro-enterprises through integrated financial and non-financial support schemes (ANADE, 2024; BNA, 2022). Its financing model typically combines bank loans with state-backed subsidies, with interest rates often fully or substantially subsidized in order to reduce the financial burden on project holders (BNA, 2022; BDL, 2020).

In addition to financial assistance, ANADE-supported enterprises benefit from a range of fiscal incentives, including exemptions from personal income tax, corporate income tax, and local business taxes. These exemptions may extend for up to six years in designated development zones, thereby enhancing the viability of early-stage ventures (Ministry of Finance, Algeria. 2023).

Beyond its financial role, ANADE has progressively expanded its mandate to include capacity-building and entrepreneurial support. This includes the establishment of entrepreneurship development centers within universities and vocational training institutions, where project holders receive training, mentoring, and guidance throughout the business creation process (Algeria Invest, 2024).

This institutional evolution reflects a broader shift from a purely financing-oriented approach toward a more integrated support ecosystem, combining access to capital, skills development, and risk mitigation. As such, ANADE now functions as a comprehensive instrument for fostering sustainable entrepreneurship and facilitating the transition from informal or idea-stage projects to structured economic activities (ANADE, 2024; Algeria Invest 2024).

- **ASF (Algerian Startup Fund)**

The Algerian Startup Fund (ASF) constitutes a key public venture capital instrument designed to support innovative, high-growth startups, particularly those that have obtained the official Startup Label (ASF, 2026; Startup Algeria, 2025). Unlike traditional financing mechanisms based on debt, ASF primarily operates through equity and quasi-equity instruments. In this model, the fund invests capital in exchange for an ownership stake in the startup, rather than requiring immediate repayment. This approach significantly reduces financial pressure and early-stage cash-flow constraints, allowing founders to focus on product development, market entry, and business scaling (ASF, 2026; Leancubator, 2025).

ASF provides multiple levels of financing, ranging from seed-stage funding to larger venture capital investments, depending on the maturity and growth potential of the startup (Startup Algeria, 2025; Leancubator, 2025). In addition to financial support, the fund offers post-investment services, including governance mentoring, access to strategic networks, and assistance with internationalization and export readiness. This integrated model—combining

capital injection with strategic guidance-positions ASF as a central catalyst within Algeria's innovation-driven entrepreneurial ecosystem (ASF, 2026; ASF, 2023).

- **AAPI (Algerian Investment Promotion Agency)**

The Algerian Investment Promotion Agency (AAPI) plays a strategic role in facilitating and promoting investment projects, particularly medium- and large-scale initiatives (AAPI, 2025; Algeria Invest, 2024). A defining feature of AAPI's operational framework is the "Guichet Unique" (Single Window) system, which serves as a centralized interface for investors. This mechanism is designed to simplify administrative procedures related to business registration, regulatory approvals, and access to investment incentives.

The Single Window system operates at multiple levels, including specialized national units dedicated to major projects and foreign investments, as well as decentralized units at the wilaya (regional) level for smaller-scale initiatives (AAPI, 2025; Web 7, 2024). This multi-tiered structure enhances administrative efficiency and improves accessibility for different categories of investors.

Projects registered through AAPI may benefit from a range of fiscal and customs incentives, including exemptions from customs duties and value-added tax (VAT) on certain goods required for investment implementation (AAPI, 2023; PwC, 2025). By streamlining administrative processes and consolidating services within a single institutional framework, AAPI contributes to reducing bureaucratic constraints and increasing the overall attractiveness of Algeria as an investment destination (AAPI, 2025; Ministry of Foreign Affairs, Algeria., 2024).

Tables 20 and 21 summarize the respective strengths and limitations of ANADE, ASF, and AAPI as complementary instruments supporting business creation and investment development in Algeria (Figure 14).

Table 20: Comparative Overview of Public Support Mechanisms for Business Creation in Algeria

Mechanism	**Target Segment**	**Financial Instruments**	**Non-Financial Support**	**Main Advantages**
ANADE	Young entrepreneurs and micro-enterprises (ANADE, 2024)	Subsidized bank loans, interest-rate support, and microcredit schemes (BNA, 2022)	Training programs, entrepreneurship development centers, and risk-sharing mechanisms (Algeria Invest, 2024)	Reduced cost of financing, tax exemptions, and facilitated access for first-time entrepreneurs (Ministry of Finance, Algeria, 2023)
ASF	Innovative startups with official labeling (ASF, 2026)	Equity and quasi-equity financing, including seed funding and venture capital (Startup Algeria, 2025)	Governance mentoring, access to professional networks, and support for scaling and internationalization (ASF, 2026)	Lower debt burden, growth-oriented financing model, and structured investment processes (Leancubator, 2025)
AAPI	Medium- and large-scale investment projects, including foreign investments (AAPI, 2025)	Investment incentives, including tax and customs exemptions (AAPI, 2023; PwC, 2025)	Single Window (“Guichet Unique”) services, administrative facilitation, and inter-institutional coordination (AAPI, 2025)	Simplified procedures, centralized administrative interface, and improved overall investment climate (Ministry of Foreign Affairs, Algeria., 2024)

Table 21: Comparative Assessment of Public Support Mechanisms in Algeria - Advantages and Limitations

Mechanism	**Main Advantages**	**Main Limitations**
ANADE	Provides strong support for young entrepreneurs and micro-enterprises through subsidized loans and tax exemptions; characterized by relatively low entry barriers and broad territorial coverage across wilaya (ANADE, 2024; Ministry of Finance, Algeria,2023).	Primarily focused on small-scale projects with limited growth potential; administrative procedures and documentation requirements may remain complex; beneficiaries may still face repayment risks despite interest rate subsidies (Algeria Invest,2024; PwC, 2025).
ASF	Offers equity-based financing that reduces debt pressure on founders; specifically targets innovative, high-growth startups; complements financial support with mentoring, governance guidance, and strategic networking (ASF, 2026; Startup Algeria, 2025).	Access is restricted to startups that meet strict labeling criteria; equity financing implies partial dilution of ownership; as a relatively recent institution, the fund is still consolidating its investment portfolio and operational processes (ASF, 2023; Leancubator, 2025).
AAPI	Facilitates administrative procedures through the Single Window ("Guichet Unique") system; provides substantial tax and customs incentives for eligible investments; includes dedicated mechanisms for large-scale and foreign investment projects (AAPI, 2025; Ministry of Foreign Affairs, Algeria., 2024).	More suited to medium- and large-scale projects than to early-stage startups; procedures may still be perceived as bureaucratic; overall effectiveness depends on coordination among multiple public institutions (AAPI, 2023; PwC, 2025).

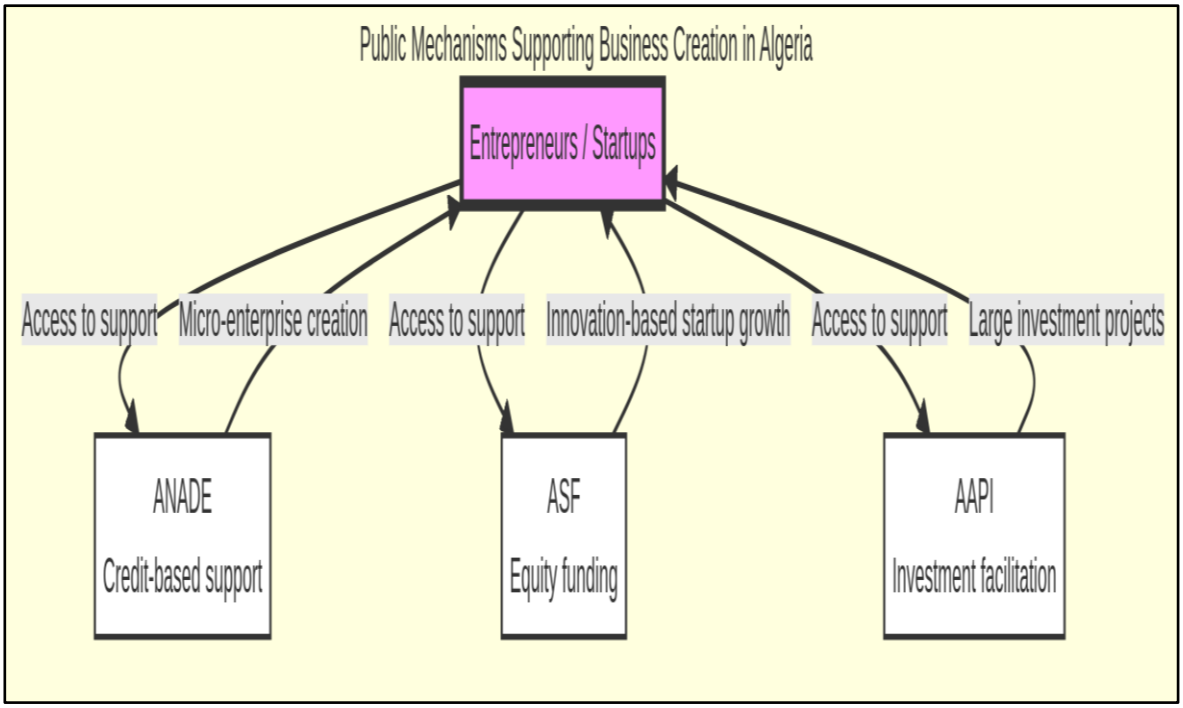

Figure 14: Complementary Roles of ANADE, ASF, and AAPI in the Entrepreneurial Ecosystem (ANADE, 2024; ASF, 2026; AAPI, 2025)

In addition to formal financing and policy instruments, Algeria Venture-together with university incubators and co-working spaces-constitutes a critical component of the national startup support infrastructure. These structures are increasingly recognized in academic literature for their role in providing mentorship, access to facilities, and overall ecosystem strengthening.

III-4-4-3-2- Support Infrastructure

Algeria Venture (A-Venture), the country's flagship public accelerator, delivers intensive acceleration programs, funding advisory services, and technical expertise aimed at enhancing startup growth, scalability, and long-term sustainability (Ghodbane et Daghrir, 2024). Its intervention model focuses not only on financial readiness but also on strategic development, including product-market fit, business modeling, and investor engagement.

University incubators represent another essential pillar of this support ecosystem. They provide a range of services, including mentoring, administrative guidance, access to funding opportunities, and capacity-building programs. Empirical studies conducted in Algerian universities-such as those of Tipaza and M'sila-demonstrate the significant impact of incubators

on startup maturation, entrepreneurial intention, and local economic development (Bensaber et Boumendjel, 2024; Hadji, 2023).

More broadly, these infrastructures contribute to the creation of collaborative innovation environments by offering shared workspaces, facilitating networking with investors and industry actors, and promoting knowledge exchange. Contemporary research emphasizes that effective entrepreneurial ecosystems require strong coordination among multiple stakeholders, including universities, public agencies, investors, and private-sector partners (Ghodbane et Daghrir, 2024).

Algeria Venture's facilities and operational model illustrate the type of physical and institutional infrastructure highlighted in accelerator studies, combining workspace provision, mentoring, and ecosystem integration to support early-stage ventures Table 22.

Table 22: Key Support Infrastructures in the Algerian Startup Ecosystem

Infrastructure	Academic Insights	Key Contributions
Algeria Venture	Provides intensive acceleration programs focused on startup development and scaling (Ghodbane et Daghrir, 2024).	Offers access to funding guidance, technical expertise, and structured support aimed at enhancing sustainability and growth potential.
University Incubators	Deliver administrative and financial support within academic environments, fostering entrepreneurship among students and researchers (Bensaber et Boumendjel, 2024).	Facilitate project maturation, innovation development, and the transition from idea to market-ready ventures.
Co-working Networks	Contribute to the development of entrepreneurial ecosystems by enabling collaborative and flexible working environments (Hadji, 2023).	Provide mentorship opportunities, shared physical infrastructure, and networking spaces that support knowledge exchange and collaboration.

III-4-4-3-3- Strategic Tools for Entrepreneurs

Algerian entrepreneurs increasingly rely on structured strategic tools to design, validate, and scale their business projects. Among these, the Business Model Canvas (BMC) is widely used, particularly in the advanced stages of project development. Its nine-block framework provides a comprehensive and systematic representation of key business components, including value proposition, customer segments, revenue streams, and cost structure. The BMC is often used in combination with earlier-stage ideation tools such as the Lean Canvas, enabling a progressive transition from concept development to full business modeling (Belkacem et *al*., 2026).

In parallel, digital payment systems such as BaridiMob and CIB play an increasingly important role in facilitating financial inclusion and supporting the digital transformation of the Algerian economy. Empirical studies indicate that a 1% increase in the use of these electronic payment systems is associated with an estimated 0.55% increase in GDP, reflecting a bidirectional causal relationship between digital financial adoption and economic growth (Kheniche et Larbaoui, 2025). These tools therefore contribute not only to transaction efficiency but also to broader macroeconomic performance and market competitiveness (Table 23).

Overall, these strategic instruments enhance entrepreneurial efficiency, strengthen financial inclusion, and support the modernization of Algeria’s emerging digital economy (Kheniche et Larbaoui, 2025).

Table 23: Strategic Tools for Entrepreneurial Development in Algeria

Tool	Scholarly Role	Impact Evidence
Business Model Canvas (BMC)	Comprehensive business modeling framework used in structured project development (Belkacem et *al*., 2026)	Supports systematic progression through business development stages, from concept validation to operational planning
BaridiMob / CIB	Digital financial infrastructure contributing to economic modernization and inclusion (Kheniche et Larbaoui, 2025)	Estimated 0.55% GDP increase for each 1% rise in usage, indicating strong economic impact

Figure 15 shows a strong and accelerating increase in the number of operational startups in Algeria between 2020 and 2026, rising from 200 startups in 2020 to 14,500 in 2026. The trend remained relatively moderate from 2020 to 2023, before experiencing a sharp expansion after 2024, with the number reaching 2,700 in 2024 and 9,000 in 2025. This pattern suggests a rapid strengthening of the Algerian entrepreneurial ecosystem, which is consistent with recent studies describing the startup environment in Algeria as dynamic, expanding, and increasingly supported by public policies and institutional mechanisms.

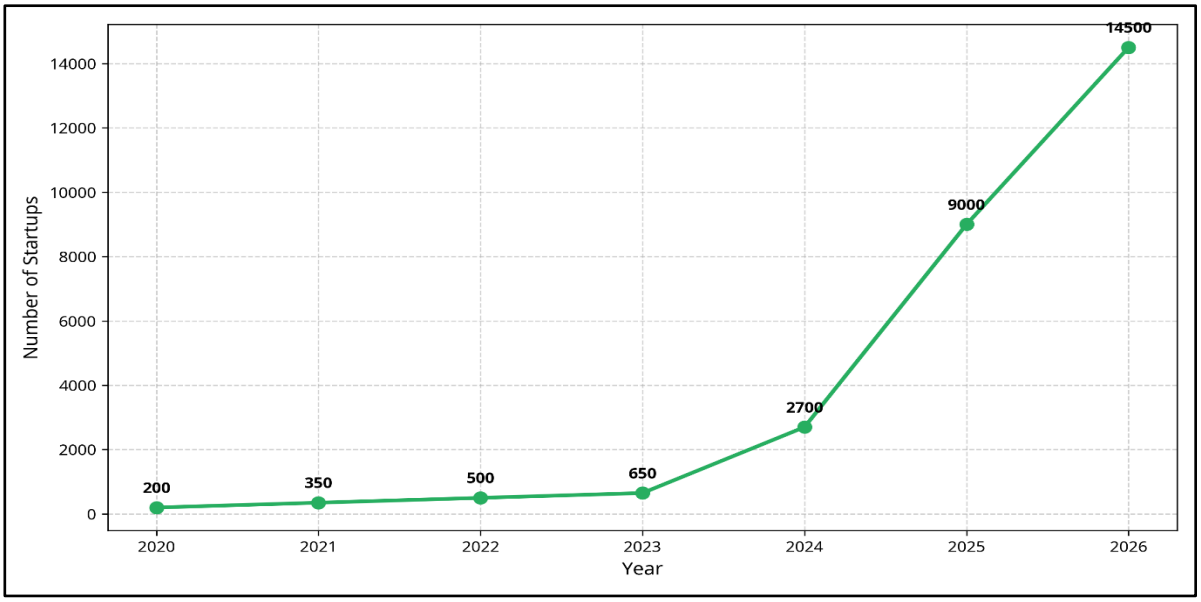

Figure 15: Growth of Operational Startups in Algeria (2020-2026) (ASJP-CERIST, 2026).

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