

Universities as Innovation Intermediaries in an Emerging Ecosystem: A Triple Helix Analysis of Algeria's University–Startup Interface

ا نموذج تحليل :ناشئة منظومة في للابتكار كوسطاء لجامعات
اللولب الثلاثي الشركات-الجامعة لواجهة الجزائر في الناشئة

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الملخص:

يتناول هذا البحث الجهات عات في الجزائر باعتبارها الدور المتطور للجامع ضمن منظومة الابتكار الوطنية، مع التركيز على مساهمتها في تطوير الفاعلة الشركات الناشئة. ورغم سعي السياسات الحديثة إلى تعزيز اقتصاد قائم على المعرفة فإن ديناميكيات التفاعل بين الجامعة والشركات الناشئة لا تزال غير واستناداً إلى نموذج اللولب الثلاثي ومفهوم الجامعة الريادية، كافٍ من الناحية النظرية مستكشفة بشكل تعتمد الدراسة منهجاً نوعياً وثائقياً يستند إلى تقارير السياسات، والأدبيات الأكاديمية، والمؤشرات الوطنية، والتوصيفات الدولية. وتشير النتائج إلى أن الجامعات الجزائرية تعمل ريجياتد على توسيع دورها في الابتكار من خلال إنشاء حاضنات ومراكز ابتكار وهياكل موجهة للذكاء الاصطناعي، إضافة إلى تعزيز انخراط الطلبة في الأنشطة الريادية. غير أن عدة عوائق تحد من تحقيق الإمكانيات الكاملة، منها ضعف مشاركة القطاع الخاص ومحدودية ات نقل المعرفة. وتخلص الدراسة إلى أن هذه العوامل تؤثر على التمويل، وضعف آلي فعالية واستدامة الابتكار الجامعي، مع إبراز الحاجة إلى مزيد من الدراسات الميدانية.

الكلمات المفتاحية: الشركات ابتكار؛ الجامعة الريادية؛ اللولب الثلاثي؛ الشركات الناشئة.

Abstract:

This paper explores the evolving role of universities in Algeria as emerging actors within the national innovation ecosystem, with particular attention to their involvement in startup development. While recent policy initiatives have sought to promote a knowledge-based economy, the specific dynamics of university–startup interaction remain insufficiently explored

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and theoretically underdeveloped. Drawing on the Triple Helix model and the concept of the entrepreneurial university, the study adopts a qualitative documentary approach. The analysis suggests that Algerian universities are gradually expanding their role in innovation. Several barriers, however, prevent the system from reaching its potential. By situating the Algerian case, this paper contributes to a more nuanced understanding of how universities operate in emerging innovation ecosystems and highlights areas for further empirical investigation.

Key words: ecosystem; entrepreneurial university; triple helix; startup; knowledge-based economy.

Introduction:

Algeria has, in recent years, undertaken a series of reforms aimed at fostering innovation, entrepreneurship, and digital transformation. These efforts have led to the emergence of a growing startup landscape, supported by public investment in incubators, innovation hubs, and new institutional frameworks (More than 5,000 startups have been officially registered, and considerable public resources have been directed towards building an innovation ecosystem through incubators, AI Houses, and broader frameworks for research and innovation support). Despite these developments, the ways in which universities engage with other actors in the innovation system, particularly in relation to startup creation, remain only partially understood.

Existing research on innovation in emerging economies has largely focused on structural constraints such as limited resources, institutional rigidity, and weak industry linkages. Comparatively little attention has been paid to how higher education institutions operationalize their role within these environments, and even less to the specific case of Algeria. This gap is significant, given the increasing expectations placed on universities to contribute not only to knowledge production but also to economic and social development. Against this background, this study seeks to examine the role of Algerian higher education in the country's evolving innovation ecosystem. More specifically, it aims to:

- examine how universities contribute to startup development and innovation,
- Analyse the institutional mechanisms that support university–startup interaction,
- assess the extent to which university initiatives align with national policy orientations,
- propose a theoretically grounded interpretation of these dynamics in the Algerian context.

Rather than assuming a fully developed innovation system, the study draws on two complementary theoretical frameworks. The Triple Helix model holds that innovation arises from the interaction of universities, industry, and the state; the entrepreneurial university theory explains the internal transformation through which universities become oriented towards knowledge commercialization and entrepreneurial activity. Together, these frameworks provide a basis for interpreting the dynamics of Algeria's emerging innovation environment. This raises the question of whether recent institutional developments reflect structural transformation or, rather, policy-driven expansion with limited systemic integration? In this respect, the Algerian case offers a useful setting for examining how innovation models adapt in contexts where institutional conditions differ significantly from those in which they were originally developed.

1-Literature Review

1.1- Concepts and Definitions of Innovation Ecosystems

The concept of innovation ecosystems has evolved considerably over recent decades, shifting from a linear view of innovation — in which knowledge flows in a straight line from research to implementation — towards a more complex, network-based understanding. Innovation ecosystems are now broadly understood as systems that connect universities, firms, government bodies, and intermediary organizations to advance technological development, entrepreneurial activity, and knowledge diffusion. Although scholars use varying terminology, most definitions converge on the idea that innovation emerges through the active cooperation of multiple stakeholders (Adner, 2017; Autio & Thomas, 2014). Key features include interdependent relationships between actors, shared resources, co-evolution, and institutional backing.

In developing countries, innovation ecosystems face distinct structural obstacles: restricted research capacity, limited industrial participation, inadequate financing, and fragmented institutional relationships. Nevertheless, ecosystem-building has been widely recognized as a strategy for achieving sustainable development, fostering entrepreneurship, and accelerating technological modernization.

1.2- The Role of Higher Education in Innovation Ecosystems

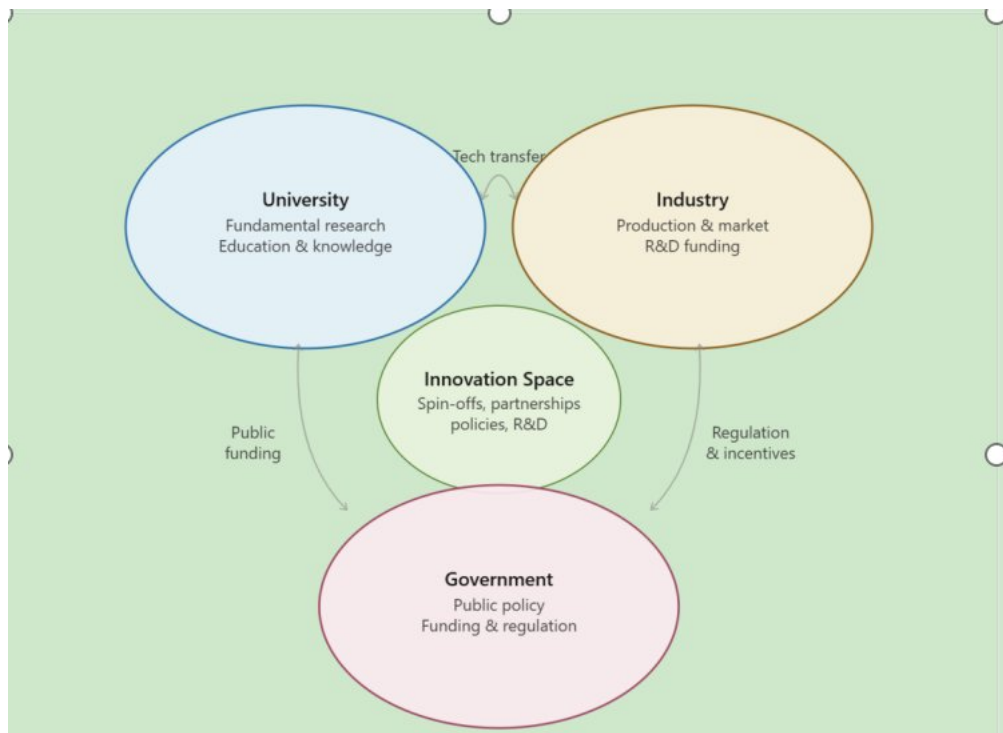
Universities occupy a central position in contemporary innovation systems. In developing countries, they often compensate for the limited research capacity of the private sector, functioning as primary producers and diffusers of knowledge. This role carries considerable expectations: higher education institutions are increasingly called upon to contribute not only to scientific output but also to economic development, graduate employability, and regional competitiveness. Realizing this potential, however, requires addressing significant structural and cultural challenges that continue to affect how universities operate in many emerging economies.

1.3- University–Industry and University–Startup Interactions

University–industry collaboration is widely recognized as a cornerstone of innovation-driven development. It encompasses joint research, consultancy, curriculum co-design, technology development, knowledge transfer, and startup creation. Strong linkages of this kind are typically associated with increased innovation output, including patents, spinoffs, and the commercialization of research findings.

In developing countries, however, these linkages are often weak or informal, constrained by misaligned incentives between universities and industry, the absence of technology transfer offices, limited absorptive capacity within firms, insufficient innovation funding, and cultural barriers to cross-institutional collaboration.

University–startup interactions represent an emerging dimension of this broader collaboration. Startups benefit from access to expertise, research infrastructure, and mentorship, while universities strengthen their innovation capacity, improve graduate employability, and amplify their societal impact. Incubators, innovation hubs, and entrepreneurship centers are the principal mechanisms through which this interface is facilitated.



Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university–industry–government relations. *Research Policy*, 29(2), 109–123.

1.4- The Triple Helix and Entrepreneurial University Frameworks

The Triple Helix Model

Developed by Etzkowitz and Leydesdorff (2000), the Triple Helix model conceptualizes innovation as a product of sustained interactions among universities, industry, and government. These interactions give rise to new institutional arrangements, hybrid organizations such as incubators and science parks, and collaborative innovation dynamics. The framework has been applied extensively to analyze innovation systems in both developed and developing contexts.

The Triple Helix model is particularly relevant in settings where state intervention plays a significant role, such as Algeria, where government-led programs substantially shape the innovation landscape and underpin university-based initiatives.

The Entrepreneurial University

The entrepreneurial university concept describes a fundamental shift through which universities transform themselves into dynamic institutions that actively encourage innovation and entrepreneurship, engaging with society beyond the traditional functions of teaching and research (Clark, 1998; Etzkowitz, 2013). This model is characterized by diversified financing, strong external networks, internal infrastructure such as incubators and technology transfer centers, organizational adaptability, and a strategic focus on knowledge commercialization. It provides an important analytical lens for understanding how universities in emerging

ecosystems adapt to new social and economic demands.

1.5- Innovation Ecosystems in Developing Countries

Studies of innovation in the Global South consistently highlight structural limitations: resource constraints, governance deficits, limited research funding, weak private-sector engagement, and dependence on state-driven initiatives. At the same time, these ecosystems often exhibit genuine potential, rooted in young and growing populations, expanding higher education systems, increasing policy attention to entrepreneurship, and nascent startup cultures energized by digital transformation.

Evidence from North Africa and Sub-Saharan Africa suggests that higher education institutions can serve as significant innovation drivers when supported by appropriate policy frameworks, governance reforms, and investment in digital and research infrastructure (see, e.g., ElHoussamy & Rizk, 2020; ADEA, 2004).

1.6- Knowledge Gap and Relevance to Algeria

Despite a growing body of literature on innovation ecosystems and university–industry partnerships, research focused specifically on Algeria remains limited. Available studies tend to address the national policy environment and startup ecosystem in general terms, with insufficient attention to the role of higher education in driving innovation and entrepreneurship. In particular, the university–startup relationship in Algeria has not been systematically analyzed; the functions of AI Houses, certified incubators, and university-based innovation centers have received little scholarly attention; and the Triple Helix and entrepreneurial university frameworks have rarely been applied to the Algerian context. As a result, the transferability of these models to contexts such as Algeria remains an open empirical question rather than an established fact. These gaps are addressed by examining Algerian universities as drivers of innovation, with a specific focus on university–startup interaction and the institutional context that shapes it.

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Table 1. Key Indicators of Algeria's Startup Ecosystem (2023–2024)

Structure / Indicator	Quantity	Source / Notes	Relevance to Article
Registered Startups	5,000+	Ministry of Knowledge Economy / Startup.dz	Baseline indicator of ecosystem scale
Certified Incubators	94	DK News; ASJP Cerist	Demonstrates structured support infrastructure
Innovation Hubs	60	ASJP Cerist	Highlights role of hubs in university–startup ecosystem
AI Innovation Houses	17	DK News	Reflects technology specialization and university-driven innovation
Patents Filed	853	Ouest-Tribune	Indicates level of innovation and IP protection activity

Table 1 presents key indicators of Algeria's startup ecosystem as of 2023–2024, covering registered startups, incubators, AI innovation houses, patents, and global ranking. These figures provide a quantitative overview of the ecosystem and contextualize the role of universities as innovation drivers.

2- Methodology

2.1- Research Design

This study adopts a qualitative research design, which is particularly appropriate to the exploratory inquiries in contexts where structured empirical data remain limited. Given the scarcity of comprehensive datasets on university–startup interaction in Algeria, a documentary analysis approach was considered the most appropriate means of capturing both policy developments and institutional practices.

2.2- Data Sources

The analysis draws on a diverse set of secondary sources, including official government reports, academic publications, international rankings, and selected media outputs. Particular attention was paid to triangulating information across sources in order to enhance the reliability of the findings and to mitigate the limitations associated with single-source data.

It is important to note that reliance on secondary data inevitably limits the level of granularity that can be achieved, particularly with regard to informal or emerging practices.

Rather than treating these materials as purely descriptive, the study applies thematic synthesis. Academic literature forms the second category, including peer-reviewed articles on innovation ecosystems and entrepreneurial universities, studies addressing innovation systems in North Africa and other developing economies, and research on university–industry relations in the region.

International rankings and global databases constitute the third category, specifically the Global Startup Ecosystem Index (StartupBlink, 2017–2024) and relevant UNESCO and OECD reports on innovation and higher education.

2.3- Analytical Framework

These themes are then interpreted through the analytical lenses of the Triple Helix model (Etzkowitz & Leydesdorff, 2000) and the entrepreneurial university framework, allowing for a more theoretically informed reading of the Algerian case.

2.4- Data Analysis Procedure

Data analysis follows a process of qualitative thematic synthesis. Core themes are identified relating to innovation structures, university function, national policy, and systemic constraints. Relevant data are extracted from each source and coded thematically. However, in contexts where primary data are fragmented or inaccessible, documentary analysis remains a necessary and widely accepted exploratory approach, and triangulated across sources before being integrated within the theoretical frameworks, with the aim of identifying the factors that facilitate or impede university–startup collaboration. Results are organized under four thematic categories: innovation infrastructure (incubators, innovation hubs, AI Houses), university-level initiatives, government policy orientation, and innovation outcomes. The aim here is therefore not to provide exhaustive measurement, but to identify patterns and tendencies that can inform future empirical research.

2.5- Scope and Limitations

The reliance on secondary sources reflects the absence of comprehensive public databases on university–startup relationships in Algeria. While documentary analysis enables a theoretically grounded examination of the topic, it carries certain limitations. Some metrics, investment volumes, for instance, are incompletely captured due to inconsistent data reporting. The rapidly evolving nature of the ecosystem means that time-sensitive information may become outdated. The absence of primary fieldwork, including interviews with incubator managers or university staff, limits the study's ability to capture the experiential dimensions of university–startup interaction. These limitations are acknowledged and point to productive directions for future empirical research.

3. Results and Analysis

3.1 Overview of Algeria's Emerging Innovation Ecosystem

Over the past decade, Algeria's innovation landscape has undergone significant change, driven by a national commitment to economic diversification and technological development. Government investment in a knowledge-based economy has produced a range of support structures designed to stimulate entrepreneurship, promote research commercialization, and

strengthen the competitiveness of Algerian startups.

More than 5,000 startups have been officially registered, reflecting rapid growth in entrepreneurial activity across digital technologies, agritech, renewable energy, and manufacturing. This expansion has been accompanied by the progressive institutionalization of innovation infrastructure, including certified incubators, innovation hubs, and AI Houses, which together form a foundation for university–startup collaboration. In this sense, quantitative growth may coexist with qualitative limitations.

Despite this progress, the ecosystem remains uneven in its development. Government involvement is strong, private-sector engagement is limited, and startup culture, while growing, is not yet fully mature. These contextual features shape the particular character of university contributions to innovation.

3.2 University-Based Innovation Structures

Algerian universities have progressively established internal mechanisms to support innovation and early-stage entrepreneurship. Three types of structure are particularly significant.

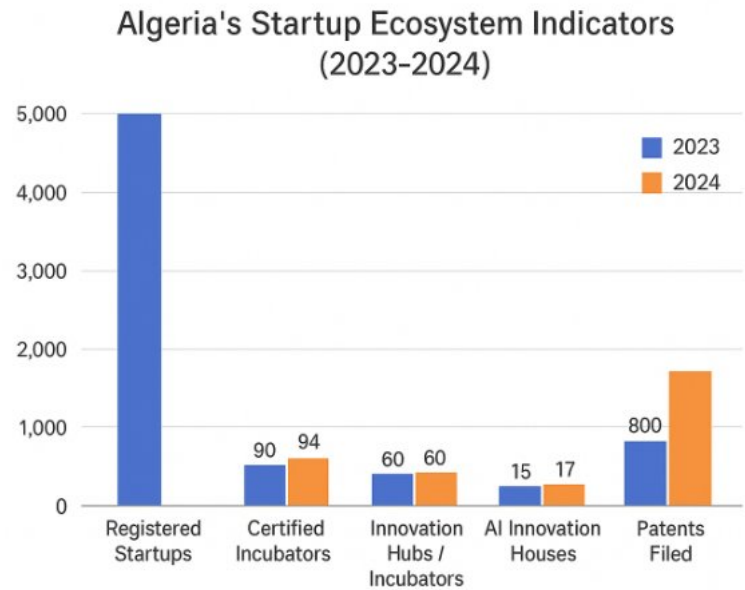
Approximately 94 certified incubators operate nationally, many hosted within or directly affiliated with universities. These facilities provide mentorship, training, workspace, technical resources, and guidance for prototype development, as well as support for obtaining the national startup label. University-based incubators have become important platforms linking academic knowledge to entrepreneurial initiative.

Around 60 innovation hubs serve as intermediary structures linking students, researchers, and innovators. Found primarily in higher education institutions and research organizations, they encourage interdisciplinary collaboration, support student-led innovation, provide digital and scientific resources, and contribute to the development of regional innovation ecosystems.

The establishment of 17 AI Houses within Algerian universities marks a significant step in strengthening the country's digital innovation capacity. Their purpose is to promote applied research in artificial intelligence, support startups developing data-driven solutions, train students in emerging digital technologies, and foster collaboration with industries engaged in machine learning and automation.

Beyond these structural developments, a growing number of universities have introduced entrepreneurship courses, pre-incubation schemes, new venture competitions, hackathons, and research contests. These initiatives reflect a broader movement towards the entrepreneurial university model and contribute to cultivating an innovation culture within higher education.

Table 2: Algeria's Startup Ecosystem Indicators (2023–2024)



As shown in Table 2, patents filed experienced the most significant growth, doubling from approximately 800 in 2023 to 1,700 in 2024, indicating increased research and innovation activity across the university sector.

3.3 National Policy Framework and Government Support

Government intervention has been central to shaping Algeria's innovation system. The national certification framework grants formal recognition to startups, innovative projects, and certified incubators, providing access to financial benefits, funding schemes, intellectual property support, and priority access to government innovation programs. To date, over 234 innovative projects and several university-based incubators have received certification.

Given the relatively limited presence of private venture capital, government-led funding schemes represent the primary financing mechanism for early-stage innovation. These schemes support prototype development, research-based business ventures, and digital innovation projects. At the policy level, universities are positioned as central actors in the development of human capital, applied research, digital innovation, and technological sovereignty — an orientation that broadly aligns with the logic of the Triple Helix model.

3.4 Innovation Outputs: Patents, Projects, and Rankings

Approximately 853 patents have been registered in recent years, reflecting growing innovation activity in which universities play a notable role through academic research, student innovation challenges, and scientific competition programs. There has also been a marked increase in student-led prototypes, university research teams entering national competitions, and faculty participation in commercialization initiatives — developments that point to expanding internal capacity within higher education institutions.

Algeria's performance in the Global Startup Ecosystem Index (StartupBlink) illustrates a substantial improvement in ecosystem standing: the country ranked approximately 546th in 2017, climbed to 114th by 2023, and stabilized around 115th in 2024. This upward trajectory reflects growing ecosystem maturity, though it also signals ongoing challenges in sustaining competitiveness relative to leading global innovation economies.

3.5 Challenges in University–Startup Interaction

Despite the progress described above, several systemic constraints limit the full potential of university-driven innovation in Algeria. Bureaucratic processes are slow, university governance structures are rigid, and innovation initiatives have limited operational autonomy, conditions that impede rapid experimentation and agile collaboration. Funding remains heavily dependent on government grants and subsidies, while venture capital participation is minimal and research commercialization is underfinanced, creating barriers to prototype development, technology transfer, and business creation.

Collaboration between universities and industry remains weak. There are few established co-development relationships, limited joint research initiatives, and insufficient engagement from firms with academic output — factors that directly discourage commercialization and applied innovation. At the level of skills and organizational culture, entrepreneurship competencies remain underdeveloped within universities, innovation management capacity is limited, and an academic culture that favors traditional research over commercial activity persists, impeding the full realization of the entrepreneurial university model.

3.6 Synthesis Through Theoretical Frameworks

Viewed through the Triple Helix lens, Algeria's innovation system exhibits a state-dominated configuration in which government initiates and finances most innovation institutions, universities have taken on an increasingly active operational role, and industry remains an underdeveloped partner that is only beginning to engage. This pattern reflects partial conformity to the Triple Helix model while highlighting structural imbalances that continue to constrain collaborative innovation.

From the perspective of the entrepreneurial university framework, Algerian universities are advancing through the development of incubators, digital innovation hubs, entrepreneurship training programs, and participation in national innovation schemes. This transformation is real but incomplete, owing to limited institutional autonomy, inadequate commercialization mechanisms, and weak research–industry synergies.

4. Discussion

The findings suggest that Algeria's innovation ecosystem is undergoing a gradual but uneven transformation, in which universities are beginning to assume a more visible and strategic role. The expansion of incubators, innovation hubs, and AI-oriented initiatives reflects a clear policy direction that positions higher education institutions as central actors in the national innovation agenda.

However, this evolution should not be interpreted as evidence of a fully functional innovation

system. The predominance of state-led initiatives, combined with the relatively limited engagement of the private sector, points to an imbalance that constrains the collaborative dynamics emphasized in the Triple Helix model. In this respect, universities appear to be operating in a space where expectations are high, but enabling conditions remain only partially developed.

From the perspective of the entrepreneurial university, the observed changes indicate a process of institutional adaptation rather than a completed transformation. While new structures and programs have been introduced, their long-term effectiveness depends on deeper organizational shifts, including greater autonomy, more flexible governance, and stronger incentives for research commercialization.

These observations are consistent with patterns identified in other developing contexts, where universities often play an expanded role in innovation due to gaps in industrial capacity. At the same time, they raise important questions about sustainability and the extent to which current initiatives can generate lasting economic impact without broader systemic changes. In this regard, the observed developments may be better understood as a transitional phase rather than a completed transformation.

5. Conclusion

This paper has examined how Algerian universities are evolving into innovation intermediaries that support a transforming national startup ecosystem. Applying the Triple Helix and entrepreneurial university frameworks to a qualitative documentary analysis, the study has shown that universities are contributing to innovation through incubators, innovation hubs, AI Houses, and increased engagement by students and faculty in entrepreneurial activities.

At the same time, the study identifies persistent structural obstacles — limited private-sector involvement, funding constraints, administrative inertia, and underdeveloped research commercialization pathways — that restrict the system's potential. Addressing these constraints will require coordinated efforts across government, universities, and industry: greater institutional autonomy for universities, stronger incentive structures for industry engagement, and more robust mechanisms for translating research into economic value.

The research paper makes a contribution to the literature by providing one of the first theoretically grounded analyses of the university–startup interface in Algeria, and offers an evidence-based account of how higher education institutions shape entrepreneurial dynamics in an emerging ecosystem. Future research would benefit from primary fieldwork, including interviews with incubator managers, startup founders, and university administrators, to complement the documentary foundation established here. This study does not claim to provide a definitive account of the Algerian innovation system, but rather to offer a structured starting point for its analysis.

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